The Journal

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VOL. VIII. 1864. No. XXXI.

Evening Meeting.

Monday, January 18th, 1864.

MAJOR-GENERAL F. W. HAMILTON, C.B., Vice-President Council of Military Education, in the Chair.

NAMES OF MEMBERS who joined the Institution between the 1st and 18th January, 1864.

LIFE.

Cape, H., Surgeon, Royal Artillery.

ANNUAL.

Macpherson, G. G., Lieut. Cldm. Gds., 1*l.*
Roupell, C. M., Capt. 2nd Midlx. R. Vol., 1*l.*
Clery, James, Capt. 100th Regiment, 1*l.*
Sparks, R. W., Capt. 7th Royal Fus., 1*l.*
Lock, H., Capt. 108th (Mad. Infantry), 1*l.*
Burgess, H. M., Lieut. Roy. Art., Ben., 1*l.*
Peacock, G., Esq., late R.N., 1*l.*
Cormick, Jno., Lieut.-Col. 20th Regt., 1*l.*
Legge, Hon. C. G., Ens. Rifle Brig., 1*l.*
Jennings, T. T., Paymaster R.N., 1*l.*
Manson, A. R., Col. H.M. Bom. Army, 1*l.*

SPITHEAD AND HARBOUR DEFENCE.

BY CAPTAIN H. W. TYLER, R.E., Railway Department, Board of Trade.

THE defence of harbours and roadsteads on a large scale is almost a new branch of engineering science. The degree of protection that is required in the present day against naval attacks is so different from what was sufficient only a few years ago, that we have no authorities to consult, no rules for our guidance, and but few precedents for con-

sideration. The application of steam has rendered vessels of war independent of wind and tide; and the addition of armour-plates has necessitated the employment of more powerful guns, both on board ship and in coast defences. An overwhelming naval force may now be concentrated without notice upon any given point of attack, in accordance with arrangements previously made, with almost a certainty that every vessel, from whatever station, will reach the *rendezvous* at the appointed time. It will henceforth be more easy to carry out sudden and combined attacks by sea than on land; and when military operations are conducted in the neighbourhood of great rivers, the possession of vessels of war for navigating those rivers will, as has been strikingly demonstrated in the course of the American civil war, be of paramount importance to success.

The nation has seen these tendencies, and our noble and far-sighted Premier, combining the wisdom of age with the vigour of youth, has seized the opportunity. Rising above party feelings, in opposition to some of his former adherents, and doing the work of his political opponents in a true conservative spirit, he has already effected what would have been thought impossible not many years ago. Through his influence, and with the assistance of many whom we have the honour of seeing here this evening, the country in general is, as regards its principal points, assuming a respectable condition of defence; and it is from no fault of his that this has not been done more effectually. Lord Palmerston has, himself, been a consistent advocate throughout for the defence from the sea of our chief naval arsenal and principal roadstead. If we should unfortunately be dragged into war with any great naval power during the present year, we shall have to blame his opponents in this matter only, for its hazardous condition. Strange it is, nevertheless, after all the labour and money that have been expended in other quarters, that the waters of Spithead and the harbour of Portsmouth should still be absolutely without any special and sufficient means of protection, either from direct attack or from distant bombardment. But that being so, I have thought that an evening at this Institution could hardly be better bestowed than in a discussion upon the means that are best adapted for their defence. This subject combines naval and military considerations of great importance, including on the one hand various questions as to the future of naval operations in the attack, and on the other the means generally that should be employed for the defence of coasts, harbours, and roadsteads.

I need only refer very briefly in this theatre, to the importance of Portsmouth and Spithead with reference to future operations in times of war.

The land fortifications, the harbour, the dockyard and arsenal, and the magnificent roadstead which lies between the Isle of Wight and the southern coast of England, and above all their situation, midway upon that coast, combine to form the most important strategical position which we possess. An army landing east or west of it to march on the metropolis, would be threatened by its garrison in flank, and any hostile naval expedition for disembarking in its neighbourhood would

be taken in flank in like manner by such vessels as might be available in the roadstead; and the two means of entrance and exit which it possesses—by the Needles on the west, and Spithead on the east—would enable them to operate in either direction, as might be required.

In former wars, the anchorage at Spithead was at all times a secure asylum, in which our men-of-war could take in provisions, stores, and munitions, without the delay of going into Portsmouth harbour, and in which our merchantmen could collect in convoys, and whence they could depart under escort. In future wars, this asylum will be still more required, for our magnificent fleets of ocean steamers; for a vastly greater number of larger merchantmen, whose sails whiten every sea, or whose funnels blacken every atmosphere; and for the more complicated as well as more powerful war steamers which are replacing the old liners. The sooner these can get their supplies of coals, repair damages, refix loosened bolts and armour-plates, and refit deranged machinery, the greater the number that will be always fit for service; or in other words, the greater will be the strength of our fleet. For these and other reasons,—for the safety of commercial vessels,—as a refuge for disabled men-of-war,—for rapidity of coaling, refitting, and repairing,—for taking in provisions and munitions,—for the safety of the dockyard and its stores,—for that of the stores lying at Spithead in readiness for our men-of-war,—in fine, to protect the roadstead from direct attack, and the dockyard from bombardment, at the same time that the utmost facilities are afforded for ingress and egress,—two things are required: 1stly. The entrance to Spithead must at all times be denied to an enemy. 2ndly. There ought to be no unavoidable obstruction in the way of our own or friendly vessels. It will, indeed, be of more importance to give every possible facility of ingress and egress to the different classes of vessels during war than in a time of peace. Obstructions would now cause delay only, and be in most cases of comparatively small importance; but in time of war they might render disabled vessels more liable to capture or destruction, by increasing the difficulties in the way of their reaching a place of safety; or they might prevent our own vessels from assuming the offensive with sufficient rapidity at the proper moment, or might of themselves be sources of danger.

The problem to be solved may be thus stated:—How can we best keep our enemies out, without offering obstacles to the entrance of our friends? And there is a further problem which may be advanced at the same time, though somewhat prematurely. How can we best secure the capture or destruction of any enemies' vessels which may gain an entrance by stratagem or otherwise, with the least risk to our own vessels lying in the roadstead?

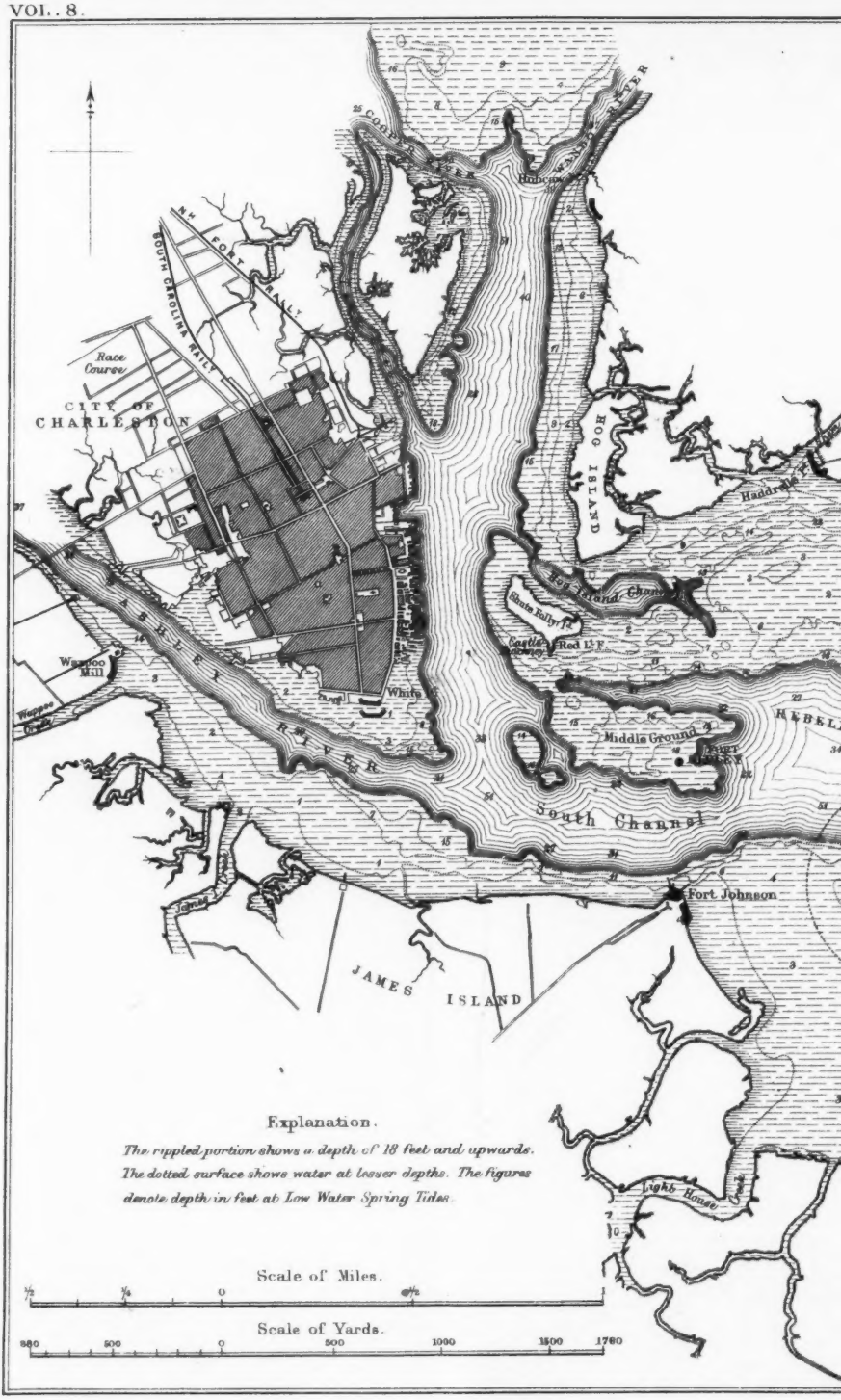
There are three passages by which a hostile fleet might attempt to force an entrance:—1stly. By the Needles' passage, the channel of which is about 1,000 yards broad near Hurst Castle. 2ndly. By the main channel into Spithead, which is about 1,200 yards wide near the Warner Light, and 1,800 yards wide opposite No-Man's-Land. 3rdly. By floating over the Horse Sand at high water, where the passage is 3,600 yards wide between the Horse Elbow Buoy and the Langston

Bar, and the same distance between the Horse Buoy and the forts on the main land. And no mode of defence can be considered to be perfect which does not provide against all these modes of attack.

There are also many means of defence, applicable to different sites and different circumstances, such as—1. Forts and batteries, where foundations can be obtained for them at a cost commensurate with the object in view. 2. Obstructions more or less permanently constructed, of iron, stone, timber, or all combined, or of sunken vessels filled with stones. 3. Floating obstructions composed of vessels chained together, and armed with guns, so as to act at the same time as floating batteries. 4. Floating obstructions, of iron and timber, or supported by casks or pontoons, intended to stop an enemy by the resistance which they offer, or to delay him under the fire of batteries. 5. Floating obstructions with a net work of cords and chains, intended to foul the screws of the enemy's vessels, and thus to arrest their progress. 6. Torpedoes, or explosive machines, either fired by percussion on being struck by a vessel, or fired from a distance when the proper moment arrives. 7. Floating batteries, to act as stationary forts, where foundations for the latter cannot be obtained at reasonable cost, or where changes of position may be desirable. 8. Floating batteries with a moderate amount of mobility, capable of changing their own position during action, and of moving to attack an enemy; and, lastly, what are popularly termed steam-rams, or vessels which are specially constructed to crush the sides of the enemy's ships by blows from their beaks, at the same time that they employ heavy guns against them as opportunity offers.

These several devices are all good under certain circumstances, and have all been proposed for employment in the defence of Spithead, but they are not all equally appplicable to this particular case. Before considering them more in detail, I propose to allude briefly to the operations at Charleston, which we have all watched with so much interest during the past year.

In the chart before you (Plate XII), I have coloured with a dark blue tint (rippled in the plate) those parts of the channel, the roadstead, and the the sea outside it, which have a depth of 18 feet and upwards, and with red the forts and the city. The distance, as you will observe, from the bar (over which there is only 11 feet at low water) to the city is about 4 miles. The entrance, 1,040 yards wide at the narrowest part of the channel between Morris Island and Sullivan's Island, has been denied to a combined naval and military force for 9 months, and is still impassable to the best iron-clad steamers that the Northern Government possesses, though Morris Island is and has been for some months in Federal hands. The inner defences, Fort Johnson, Fort Ripley, Castle Pinkney, &c., have not yet been, and do not appear likely to be, called into play. The only Federal vessel that has ventured within 700 yards of the Confederate heavy guns—the Keokuk, was obliged to be withdrawn in a sinking condition, and afterwards sank from the effects of 90 of their shot. The tattered flag of Sumter still waves aloft, though the gorge-walls on the south of that fort, originally weak and exposed, have long since been pounded into brick-dust; but it still bids defiance to the utmost


CITY OF CHARLESTON
Race Course
SOUTH CAROLINA RAILWAY
Mt. PLEASANT
COOPER RIVER
ASHLEY RIVER
Hudson
HOG ISLAND
Haddrells P.
Fort Island Ch.
Shute Folly P.
Castle Pinckney
Red L. F.
Middle Ground
Beacon
South Channel
Fort Johnson
JAMES ISLAND
Light House
WESTERN RIVER
Wappoo Mill
Wappoo Creek
White
Explanation.
The rippled portion shows a depth of 18 feet and upwards.
The dotted surface shows water at lesser depths. The figures denote depth in feet at Low Water Spring Tides.
Scale of Miles.
½ ¼ 0 ½
Scale of Yards.
880 500 0 500 1000 1500 1760

CHARLESTON HARBOUR.

J.R.Jobbins

efforts of modern artillerists. Friend and foe must alike admire the gallantry and determination with which it has been defended. The defence of so small a fort for so great a length of time, and under such a bombardment, has no parallel in history. It is said that 15,583 shots were fired at it up to November last, of which 12,302 struck, and that the flag-staff had then been shot away 34 times, but that only 27 of the garrison had been killed and 6 wounded, which involved an expenditure of 45 tons of iron and 3 tons of powder to each casualty.

We have no good authentic intelligence as to the details of the Confederate arrangements. It is said that they have constructed a framework of rough netting, attached to cables, and floated on casks, between Fort Sumter and Fort Moultrie, for entangling the screws of vessels; that they have driven piles between Forts Johnson and Sumter; and that there are other obstructions of a similar character behind this first line. We have heard occasionally of the explosion of torpedoes, and of rafts affixed to the Federal vessels as a protection against them. Certain Confederate iron-clads are reported also to have lain inside the obstructions, ready to attack any vessel which might succeed in passing them, but they do not appear to have been of a very formidable character. One of them, the "Atalanta," has since been sunk without much difficulty. The naval attack which was made on this position on the 7th of April, 1863, and from which we may draw some important lessons, was conducted as follows:—

In calm weather, which was essential to the operations of the unseaworthy vessels of the assailants, and during the spring tides, which gave an extra foot of water on the bar, nine iron-clad vessels advanced up the main channel at cable length distances. They were supported by five other gun-boats, not protected by armour, kept in reserve outside the bar, and were ordered to fire on Fort Sumter as soon as they got within range. The "Weehawken" led the way, with a raft attached to her bows, to protect her against torpedoes, and to push away other obstructions; but the raft got out of order, and the whole fleet was delayed for an hour, from 12.30 to 1.30, at some miles from the entrance, on this account. At length they were got in motion again; they rounded Morris Island, unopposed by batteries Wagner and Bee, and the defenders only opened their fire as the "Weehawken" came within range of Fort Sumter and Sullivan's Island batteries. The "Weehawken" now met with fresh disasters. The screw became entangled in the cable previously referred to, which stretches across the channel. She got in between Forts Sumter and Moultrie, followed by the other vessels. The "Ironsides," drifting with the tide, and refusing at slow speed to obey her rudder, fell foul of the "Catskill," and of the "Nantucket" which followed her; and the fleet was exposed while thus in confusion to the fire of the Confederates. The "Keokuk," which had brought up the rear, advanced to within 700 yards of Fort Sumter, and was only withdrawn in a sinking condition. The remaining vessels, with their turrets jammed, or their plates pierced, or their machinery disabled, retired in time to avoid further disasters; a half-hour's engagement at the entrance of the roadstead having

proved to be a sufficient experiment. Fortunate it was for them that they did not penetrate further. They have not ventured now, in nine months more of the siege, after all the bombardment to which Sumter has since been subjected, and even with Batteries Wagner and Bee in the hands of the Federals, to make a second attempt.

The official reports which were made by the Commanders of the Monitors to Admiral Dupont immediately after the failure of the attack, and which were submitted to Congress by Secretary Welles during the past month, establish conclusively the defects of these vessels, and show that they were quite incapable of resisting the fire of the Confederate guns.

The pilot-houses were neither safe for their inmates, nor convenient for observation. The turrets and port-stoppers were damaged and jammed, and were effective only in preventing the action of the gunners, and the use of the guns that they were intended to protect. Eleven plates, each an inch thick, in the turrets, were not proof against 11-inch shot. The sides and decks of the vessels were penetrated, so as to admit the water, by shots which sometimes struck two or three in the same place. The officers of the "Passaic," the "Patapsco," the "Nantucket," the "Nahant," and the "Weehawken" (which has since gone down at her moorings), all bear somewhat similar testimony. The same mail that brought the above reports, brought also, curiously enough, the intelligence that a severe gale had seriously injured the Confederate obstructions in Charleston Harbour, and sufficiently, it was believed, to render them ineffective against the Federal fleet. But we do not hear of any renewed attack of a formidable character.

The Confederates have since the attack of April, 1863, had ample time, sufficient means, and an able Commander, and the Federal Admiral is no doubt justified in believing that any attempt to force his ships past Sumter and Moultrie, and the first line of obstructions, would be hopeless; and that such an attempt, if persisted in for a sufficient length of time, would only lead to an enormous advantage to the Confederates, in sinking or capturing the Federal squadron, and in opening the port of Charleston more freely to the blockade runners that cannot even now be altogether prevented from resorting to it.

The means which have been adopted at Charleston, of employing forts in combination with obstructions, were evidentally suitable in that particular instance, and are more or less applicable in all similar instances. They are the same that were employed successfully at Cronstadt, as well as at Sebastopol. In the former case, the Russians kept our ships outside by an obstruction constructed in shoal water, and kept their own ships in reserve, under the protection of their works; and in the latter case they sank a portion of their fleet across the mouth of their harbour. Our fleet abstained from attacking Cronstadt, and our naval attack upon Sebastopol was not attended with any great result.

But the attack on Charleston is more instructive at the present time, because it leads more directly to the consideration of the relative advantages and difficulties which present themselves in the attack, or

which are on the side of the defence, when modern means and appliances are employed. The Confederates had placed batteries in the best positions that offered, and had obstructed their channels as well as time and opportunity would permit. They had only to stand to their guns when the attack was made, and to inflict with them the utmost damage upon the enemy. The Federals had prepared a powerful fleet, from which they expected great results; but they hardly knew what they had to encounter, and they were obliged to reconnoitre (from inconvenient pilot-houses) as they proceeded, and to experimentalize, with considerable risk to their whole fleet, in their assault.

They were repulsed (1stly), because the sides of their ships were not proof against the projectiles which they encountered; (2ndly) because their turrets could not bear the test of actual service; (3rdly) because their vessels were delayed under the enemy's guns.

The first and second reasons are of importance with regard to the future construction of ships, and the size of the guns to be used in them and against them, and are obvious in their application. The third is that on which I would now lay most stress. It will have been seen how little, after all, the Confederate obstructions were required to do. Only one vessel, the "Weehawken," whose screw caught a hawser, was directly affected by them. The others were somewhat checked in their progress by the delay occasioned to the "Weehawken," and were thus thrown into partial confusion, and diverted from their original course. The "Ironsides" was not stopped by the enemy's fire, or by his obstructions, but simply by refusing to obey her rudder when caught in the tide-way. The remaining vessels were brought up, either by collision with the "Ironsides," or in consequence of the necessity for keeping them together; and half an hour's firing then completed their discomfiture.

This delay to the Federal vessels exemplifies three things which it is important to bear in mind: (1stly) the disadvantage under which an attacking fleet labours in endeavouring to force its way through between batteries or forts when any of the foremost vessels become disabled or are delayed in their progress; (2ndly.) the disadvantage of trusting to the rudder alone for the means of steerage in such an attack; (3rdly) the necessity for protecting the screws of vessels by iron casings preparatory to such an attack. And there is shown on the other hand, (1stly) the importance of checking or disabling the *foremost* vessels of any fleet attempting to force its way through an entrance of moderate width; (2ndly) the advantage of enforcing, by whatever means, a slow speed upon hostile vessels passing forts or batteries, and particularly in a tide-way; (3rdly) the advantage that may be derived from the use even of obstructions formed of cables, where the screws of the attacking vessels are exposed to their action; (4thly) the risk generally run by an attacking fleet in attempting to run past strong forts guarding the entrance to a tidal harbour, powerfully armed with heavy guns, and aided by obstructions. And it must not be forgotten that such guns as those which I may call the Big Will class, with steel projectiles, will prove as destructive to Warriors, Enterprises, and Royal

Sovereigns, as the Confederate guns did to the inferior Monitors against which they were employed.

But in applying the lessons of Charleston to the defence of Portsmouth and Spithead, we ought to form a proper estimate of the relative size and importance of the two places, as well as to understand the different conditions involved in the two problems. Charleston, however dear to the people of South Carolina, and sacred in the eyes of its inhabitants, is not a place of first-rate strategical importance. It owes its safety from land attack to the swamps which surround it, and its commerce to the swift shallow steamers that run the gauntlet of its constant guardians. In size and capabilities its harbour bears a less proportion than Southampton Water to the Solent and Spithead. The nature of the navigation, and the bar over which it is approached, account partly for the construction of the vessels that have been employed to attack it; and its narrow channels afford facilities for defence by a succession of forts and batteries, which leave no secure haven for any hostile vessel which may succeed in passing the entrance. The obstruction of those channels does not place the Confederates under any great disadvantage, or seriously impede the operations of the few vessels of a peculiar class which they wish to admit. All honour to them for the skill and success with which they have conducted their defence, and may the city continue to avoid the fate that would follow upon its capture! But it is far inferior in naval and military importance to what ought to be our own principal stronghold.

The shores of the Solent and Spithead, on the other hand, are far too extensive, and the distance between the Isle of Wight and the main land is much too great, to admit of a similar system of defence. The dark blue tint on the chart (as shown by rippling in Plate XIII) exhibits the extent of water with a depth of 30 feet and upwards at low water spring tides, and the light blue tint (shown as a dotted surface), the extent of water at lesser depths. At the Needles' entrance on the west, there is a channel comparatively long and narrow, through which the tide runs with great rapidity. This channel would not be suitable for obstructions if it were desirable on other accounts to use them, but it is capable of defence by the *succession* of forts and batteries which is in progress, and which an enemy could not pass without great risk. The entrance to Spithead on the east could not be effectually defended in this manner without constructing a number of forts in water of greater or lesser depth, inasmuch as the distances from Southsea Castle and Gillkicker Point on the north, to Nettlestone Point and Ryde on the south, are respectively 7,000 and 5,000 yards. The distance from the Warner Light on the east to the Needles' Light on the west, measured along the middle of the roadstead, is 27 miles; and it would be as impracticable to cover this vast extent of inland water by the fire of guns as it is undesirable—for the reasons already stated—to obstruct the entrance to it.

The problem, therefore, which we have to solve differs most materially from that which has been solved at Charleston. The Con-

federate engineers had a confined space to work upon, approached over shallow water and by intricate navigation, and there was nothing to prevent them from placing obstructions in positions convenient for defence, and batteries which should command the whole harbour. British engineers, naval and military, if they defend Spithead and the Solent as they are worthy of being defended, are called upon to devise some means of securing a wider and easier entrance against attack by vastly superior forces, at the same time that they leave it unobstructed to friendly vessels, and to provide the means of capture or destruction to any hostile vessels that may chance to gain admission.

In reviewing the different systems of defence that have been proposed, that of the Commissioners on National Defence, as detailed in their first able report of the 7th February, 1860, will first claim attention. They recommended in addition to the existing defences, that (1) for the immediate defence of the entrance to Portsmouth harbour, additional batteries should be erected at Southsea Castle, and a floating barrier moored across it at a time of expected attack. (2.) For defence against a landing at Portsea Island, Cumberland Fort should be fully armed, and a road should connect the works between Southsea Castle and Cumberland Fort. (3.) For defence against a landing in Stokes Bay, the rampart and wet ditch then in progress should be completed. In regard to the defence of Spithead and of the Dockyard against bombardment, they considered that (1) the Dockyard could be set on fire and almost entirely destroyed by rifled ordnance from a distance of 8,000 yards. (2.) An enemy's flotilla of small vessels, armed with rifled guns, might occupy Spithead and the Horse Sand, and might, without approaching nearer than 3,000 yards to the then existing works, bombard the Dockyard with comparative impunity. (3.) Such vessels, being continually in motion, would incur but little risk. (4.) They might by careful attention to the soundings be independent of buoys and light-ships if these were removed.

They agreed upon two points, in which we shall probably all concur (1stly), that batteries alone could not, in such a situation, be depended on for arresting the passage of steam-ships able to pass them at great speed. (2ndly.) That the enemy's vessels would not attempt to pass them unless they had an important object in view, such as the destruction of a fleet or a dockyard, or unless there was a space to be reached beyond them where they would be comparatively unmolested. And they came to the conclusion that under all the circumstances (1stly), a permanent barrier was not desirable across the Horse Sand, because (*a*) it would be costly and difficult to construct in a sufficiently substantial manner in such a locality, (*b*) it would impede the navigation of small vessels, (*c*) it might affect the form of neighbouring shoals and the channel into Portsmouth harbour; (2ndly) a boom across the channel would be practically useless without a barrier across the Horse Sand; (3rdly) "as the best means of bringing a "heavy fire to bear on every point from which the Dockyard could be "bombarded," forts should be constructed—two on the Horse Sand,

THE DEFENCES OF
PORTSMOUTH & SPITHEAD.
1864.

NOTE. *The space within the rippled Lines shews the extent of Water with a depth of 30 Feet and upwards at Low Water Spring Tides.*
The dotted space between the rippling and the Coast Line shews the extent of Water at lesser depths.
The Numbers indicate the depths in Fathoms at Low Water Spring Tides.

Explanation.

The Forts proposed by Capt.n Tyler are shewn thus ◉ *The "Spit" and "Intermediate" Forts proposed by the Defence Commissioners but not approved by the Government, are shewn thus* ◉ *The Forts proposed by the Commissioners and intended to be carried out by the Government, are shewn thus* ◉
The dotted Circles round certain of the Forts show a range of 1000 Yd.s

N.B. Forts proposed by Admiral Milne's Committee, July 1864, are shewn thus ◎

SOUTHAMPTON WATER
Calshot Castle
Beaulieu River
Stansore Pt
Stone Pt
LYMINGTON
Noah Pt
Lymington Pier
Lymington River
Milford
Quay Haven
CHRISTCHURCH BAY
NORTH CHANNEL
SOLENT CHANNEL
YARMOUTH ROAD
Hampton Pt
Fishbourne Pt
Gurnet Pt
West
Newtown
Parkhurst Forest
Shalfleet
Carisbrooke
Yarmouth
Fort Victoria
Cliff End Fort
Hill Trees
Golden Hill Fort
Warden Pt Batt.y
Freshwater
Hatherwood Pt Batt.y
Headon Hill
Nodes Beacon
Needles Point Batt.y
Needles
Alum Bay
Freshwater Bay
Barracks
Afton Down
ISLE OF
Brook
Brook Pt
Mottestone
Brixton
Barnes Hill
Atherfield
Atherfield Pt
Chale

Scale of Miles.

1 ¾ ½ ¼ 0 1 2 3 4 5 10 Miles

1000 500 0 1000 2000 3000 4000 5000 10.000 15.000 17.600 Yards

Scale of Yards.

J. R. Jobbins, Litho Warwick Cr Holborn

Fort Wallington
Ft Nelson
Ft Southwick
Ft Widley
Crookhorn Redoubt
Fort Purbrook
Farlington Redoubt
Fareham
Titchfield
Wimmering
Cosham
BRIGHTON RAILWAY
Porchester
SOUTHAMPTON WATER
Fort Fareham
SOUTHAMPTON & GOSPORT RAILWAY
CHICHESTER
PORTSMOUTH HARBOUR
Hilsea
LANGSTON HARBOUR
Calshot Castle
Elson Fort
Elson
Brockhurst Fort
PORTSEA ISLAND
Rowner
Rowner Fort
Magazine
Dockyard
PORTSEA
Grange Fort
GOSPORT
PORTSMOUTH
Milton
HAYLING ISLAND
Calshot Spit
Gomer Fort
Alverstoke
Lee Point
Southsea
Cumberland Fort
Hayling
Eastney Batt.
West Winner
East Winner
Stokes Bay
Pier
Anglesea
Hamilton Battery
Fort Monckton
Southsea Castle
Hayling Bay
Ryde Middle
Gilkicker Pt
Spit Sand
LANGSTON BAR
SPITHEAD
HORSE SAND
West Cowes
East Cowes
Cabern Park
Royal Yard
Peel Bank
Barton Pt
MOTHER BANK
Outer Spit
Sturbridge
Inner Spit
Light
Wooton Pt
Ryde Sand
No Mans Land
Northwood
Wooton
Binsted
RYDE
Puckpool Mortar Battery
Warner
MEDINA RIVER
Nettlestone Pt
Parkhurst Forest
Barracks
Horestone Pt
ST HELENS ROADS
St Helens Pt
NEWPORT
St Helens
Carisbrooke
Castle
Bembridge
Bembridge Pt
Brading
OF WIGHT
Yaverland
Bembridge Fort
Bembridge Down
Redcliff Battery
Princessa
Yaverland Battery
Culver Cliff
Culver
Sandown Fort
Sandown
Sandown Barrack Battery
Sandown Bay
Shanklin
Shanklin Chine
Shanklin Down
Atherfield
Atherfield Pt
Chale
Bonchurch
Ventnor
St Catherine Hill
Niton
St Lawrence
Luccombe Chine
Blackgang
Compass: Magnetic

a third on the Spit Sand, a fourth on No-Man's-land, and a fifth on the Sturbridge Shoal, besides the batteries on the shore of the Isle of Wight near Nettlestone Point and Apsley House; (4thly) these proposed works, with others existing or in progress, viz., Fort Cumberland, Southsea Castle, the batteries Lumps and Eastney, Fort Monkton, the batteries on the Stokes Bay line, and that on Gillkicker Point, would effectually command the anchorage and prevent an enemy's fleet from occupying any position from which a bombardment of the Dockyard could be attempted without previously silencing two or more of the principal works.

As regards the Needles' passage, the Commissioners believed that the strong tide which runs through that channel would give great assistance to an enemy's vessels passing in with the flood, and they did not consider that any amount of fire which it would be practicable to bring to bear upon it would suffice to keep out an enemy's steamers, provided the officers in command had a sufficient object, and were determined on risking the loss which they would probably sustain in the attempt. They did not imagine either that the Solent or Southampton Water would offer adequate inducements, or that an enemy would push through to land troops for attacking the land defences of Portsmouth or the Isle of Wight, unless he had first silenced the batteries in the passage; and they came to the conclusion that if the fire directed upon it were made heavy enough to cripple an enemy's squadron, it was not likely the attempt would be made. They recommended, therefore, that batteries should be placed (1stly) on Warden Point, (2ndly) on Hatherwood Point, (3rdly) on the Needles' Point, and (4thly) that the works at Hurst Castle should be improved; and they considered that floating batteries would form a valuable auxiliary to any portion of the sea defences which might be threatened with attack.

They objected, however, to stationary floating batteries, and advocated the adoption of moveable floating batteries in the form of powerful iron-sided steam-vessels, which should be capable of maintaining a fixed station or manœuvring in a general engagement, should mount 12 to 20 guns, should have a speed of from 8 to 10 knots, and should be as light in draught as was consistent with other good qualities.

The present project for protecting Spithead from attack, and the Dockyard from bombardment, is to construct three forts, one on No-Man's-land, and another on the Horse Sand, to protect the main channel; and one on the Sturbridge Shoal to defend the interior of the roadstead; and to omit the "Intermediate" and Spit Sand Forts altogether. As these three forts alone would obviously not efficiently protect the roadstead, it is proposed also to construct large mortar batteries on the shore of the Isle of Wight, and at Southsea and Gillkicker Point on the main land, under the idea that they will command the area from which the Dockyard may be bombarded, and will be able to drop their shells into any enemies' ships that may venture inside the forts. It is further, I believe, intended to combine with these means of defence the use of moveable floating batteries,

though none are yet being prepared for the purpose, and floating obstructions.

The Needles' defences are in an advanced state of progress as far as the forts and batteries are concerned, and there is an idea, it appears, of supplementing them also, if the necessity should arise, by floating batteries moored midway in the channel, and by booms and nets stretched to stop the way, and to foul the screws of hostile vessels, under the guns of the forts.

No definite proposal appears to be yet entertained for defending the portions of the Horse Sand over which an enemy's vessels might pass at certain times of the tide, in substitution for the "Spit" and "Intermediate" forts originally proposed by the Commissioners, though the distance between the outer Horse Sand Fort and the Southsea shore is about 3,600 yards.

The reports of the Commissioners and the proposals of the Government have, as might be expected, given rise to much discussion, both in the House of Commons and by officers of both services and others elsewhere; and the warmest opponent of the Commissioners, a gallant naval officer, has more than once favoured us with his views in this theatre. In his paper of 1861, Captain Coles arrives at the conclusion that "concentration and mobility will, in his humble opinion, effect more"—I use his own words—" for the protection of England's coast and England's metropolis than any fortifications, though built of gold itself. Forts in these days of long range (which we may daily expect to increase), I consider (he says) mere *man-traps*, excellent if the object is to shut men up for the purpose of being harassed or destroyed." He gives a glowing picture also in the same paper, of the forts serving as beacons, of the enemy running through the channel at full speed alongside and among fleets of merchant-vessels laden with the wealth of the country and lying at Spithead,—of the forts being unable, in the smoke and confusion, to distinguish friend from foe, and not daring to fire from the impossibility of hitting the one without risk to the other,—of the enemy "picking up" vessels which they considered worthy of capture, and setting fire to the remainder,—and of their incidentally despatching a few ships to destroy Southampton, Osborne, Ryde, and Cowes. He does not tell us what would be the conclusion to this little morning's work, but we must suppose that in order to make good their escape they would not think it derogatory to their dignity to pass once more between the forts with all the speed that they were able to command.

Captain Coles's remedy, by which these dire results are to be avoided, is, as stated in the same pamphlet, to do away with all *sea* forts at least, and to confide in twenty iron-cased ships, and ten small ones, costing £6,000,000, possessing an average speed of twelve miles an hour, constructed expressly for coast purposes, "and ready on the first telegram of approaching hostile force to concentrate on one point." But as these vessels are to be sufficient for the defence of all the other dockyards and roadsteads, as well as Portsmouth and Spithead, and to mount guard besides along the whole assailable coast-line of Great Britain, it is difficult to understand how we are to secure

their presence at the moment they are required in any particular spot. If, on the one hand, they are scattered round the coast without any fortified harbour to resort to, they will inevitably be cut off and beaten in detail. If, on the other hand, they are to adopt the combined system of concentration and mobility which Captain Coles also advocates, they will then be necessarily moved hurriedly from point to point at a time of threatened attack, and will certainly not be within reach—as the enemy will take good care—when an attack in force is actually made. Indeed the very reason urged by Captain Coles,—that Portsmouth and Sheerness are two hundred miles and seventeen hours of steaming apart on the one side, and Portsmouth and Plymouth are a hundred and seventy-five miles and fifteen hours of steaming apart on the other, is itself conclusive against such a scheme. And on which point they are to concentrate when two admirals telegraph "approaching hostile forces" from opposite points, it would be difficult to determine. In his reply to the Commissioners' second report, also in 1861, Captain Coles changes his ground, and places the issue—not between his coast-patrol and a system of separate or individual defences—but between the mixed scheme of forts and floating batteries advocated by the Commissioners for Spithead on the one hand, and the converted vessels with a speed of seven miles an hour, which had been proposed by Sir Richard Dundas for the defence of Portsmouth only, on the other. We shall all concur, as I have said, in believing with the Commissioners that something more than the proposed forts is required for defending the roadstead; but Admiral Dundas proposed to employ the converted "old liners" to which Captain Coles refers, not as auxiliaries to, but as substitutes for the forts, because they were capable of being prepared for service with less delay and at less expense. Such vessels cannot, however, be expected to contend successfully, at all events without the assistance of the forts, against the class of vessels that are likely in future to be employed in the attack. It is clear, moreover, that forts, so far from being of less use than formerly, as Captain Coles implies, in these days of long range, become more and more formidable auxiliaries for protecting the entrance, as the range of the guns and the efficiency of the projectiles increase; and in the very unfavourable contrasts as regards the forts that Captain Coles has drawn in his second paper between forts and ships, he has omitted to state that such forts as would be constructed would have superior advantages in steadiness of platform and accuracy of fire, would never run ashore or foul of one another; could not be disabled in rudders, screws, or machinery; might carry heavier guns and heavier armour; would be far cheaper to maintain during a series of years, and would be practically in as good fighting condition at the end of an action as at the beginning of it.

The other schemes that have been proposed, have reference principally to the obstruction, rather than to the defence of the entrance to Spithead. Mr. Brooks has ably advocated in this theatre the construction of a permanent obstruction and breakwater between the Horse Elbow Buoy and the eastern entrance to Langston harbour

which would, he believes, be the means of converting into land a considerable portion of the Horse Bank, of causing an increased scour over the sea-bar of Portsmouth, and of clearing out a new channel into Langston harbour. Mr. Michael Scott has published an interesting pamphlet, in which he proposes a system of foundations to be built above water and sunk in their places. He would apply this system, not only to the forts, but also to a series of cylinders stretching across the Horse Sand. Sir John Dalrymple Hay has proposed a floating obstruction of twelve ships chained together across the main channel behind a boom, with twelve manœuvring vessels in their rear; and I hope that this scheme, coming from so eminent an officer, will meet with some attention in discussion. It would certainly appear at first sight to be a most unworthy mode of employing twenty-four of Her Majesty's ships and their crews. The ships so chained together behind a boom, would surely combine all the disadvantages of forts and stationary floating batteries without the advantages of either, and would be unable to use their broadside guns, excepting only those of the two exterior vessels while an enemy was in the act of passing them. They would be open to an attack in flank and rear across the Horse Sand, and, worse than all, the twelve manœuvring vessels behind the twelve chained vessels, and all behind the boom, would be badly placed for an attack upon the enemy at the proper moment, a situation in which I am quite sure that neither Sir John himself, nor any other British officer in command of a ship, would like to be placed.

If a boom were to be employed, it could be more effectually defended by one fort at each end of it, provided the range were moderate, than by twenty-four vessels so placed behind it. But the main argument against all these systems of obstructions, is that which I have already stated, namely, that it is still more necessary that our sea-going merchantmen, our coasting vessels, and our vessels of war, should have free access to, and a secure asylum in, these waters, during war than in time of peace.

We must also consider (independently of the above scheme) what the adoption of a complete system of obstructions, if such were employed, would really lead to. They would be required (1stly) across Portsmouth Harbour, as proposed originally by the Defence Commissioners; (2ndly) across the Horse Sand; (3rdly) across the main channel south of it; and (4thly) across the Needles' Passage. They would altogether be nearly four miles long: they must accommodate themselves to the rise and fall of the tide, and be sufficient to resist, not only the greatest storms, but also the impact of the heaviest ships at all points. Obstructions, to answer these conditions, could only be prepared at an enormous cost, and in a considerable length of time. They would be difficult to store, and expensive to maintain. The very fixing them in their places when they were required, or when war was declared, and removing them to store afterwards when they ceased to be wanted, would be an operation of great magnitude; they are not likely to be constructed while peace lasts, and I think we have only to look them in the face, and practically to consider their nature and extent, in order to determine at once that they are not the means on which

we must depend, or which are suitable, for the defence of Spithead. The application even of lighter obstructions, in the shape of net-works of chains and hawsers, would be an impediment to the navigation of our own vessels only, because they might be rendered useless in the event of a regular organised attack by the temporary addition of iron cages for the protection of the screws of those of the enemy.

Torpedoes have never yet produced all the results that have been anticipated from them, but they may no doubt be very usefully employed under some circumstances in narrow channels. In the present instance they would be dangerous as well as obstructive to our own vessels, and they are certainly not well calculated for the defence of so extensive an area.

The mortar batteries at Puckpool in the Isle of Wight, and at Fort Monkton and Southsea Castle, between three and four miles from it on the opposite coast, might, no doubt, be of some use as auxiliaries if no better means of defence could be devised. But mortars are better adapted for the bombardment of large and stationary objects, such as a dockyard or an arsenal, than for firing at moving vessels and at uncertain distances, over a range that may be counted by miles, and upon what ought to be a place of safety for our own shipping. It is surely a retrograde step in the present day, when we have got guns to carry large projectiles for similar distances, at sufficiently high angles of elevation to drop into the decks of vessels, and with greater accuracy, to adopt such an expedient; and mortars so placed can only be brought to bear upon an enemy after our own vessels have retired. One 13 lb. shell, dropped upon a vessel and exploding beneath her deck, would certainly produce a great effect, and might lead to her being sunk or captured; but a number of shells might be discharged before one vessel would be struck at a range of a mile and a half, even if they were stationary; and it would be a mere chance whether one were hit at all in a day's practice, if they were kept moving, as they certainly would be, while exposed to this or any other fire.

I need not stop to inquire whether forts are required to assist in the defence of the entrance to Spithead, because that question has now been practically decided. I presume that whatever doubts have hitherto existed as to the desirability of constructing them, have been dispelled by the performances of "Big Will," by the penetration of some of Mr. Whitworth's projectiles, and by the recent experiments with steel shot; but I think that the precise position which these forts should occupy is a question that is well worthy of further discussion. They clearly cannot be so placed as efficiently to command the whole anchorage, and still less to command the whole of the waters between Spithead and the Needles, as well as the entrance; and we must therefore seek for the best positions in which they will command the entrance, and organise some other mode of defending the interior.

The site of the proposed Sturbridge Fort is about 3,800 yards and 5,200 yards from the sites of the forts intended to be constructed on No-Man's-land and the Horse Sand, respectively, and 6,200 yards from the dockyard. The circle which I have drawn upon the chart shows the area of water which it would command at a range of 1,000

yards; and it will be observed that there is a space (marked with a dark shade) opposite the mouth of Portsmouth harbour, and 4,600 yards from the dockyard, which would be 2,300 yards from any fort or battery. It so happens also that the foundations for a fort on the Sturbridge shoal would be both difficult and costly, as it is composed of nothing but soft mud to a very great depth. Considering that it would, in combination with other works, only afford partial protection to the roadstead, and that its value in that respect will not justify a very extravagant outlay, I can come to no other conclusion than that we should do wisely in abandoning all idea of it, and in employing such forts as are constructed for the defence of the entrance only.

The proposed forts on No-Man's-land and the Horse Sand, the former at 7,600, and the latter at 6,600 yards from the dockyard, would be about 2,000 yards apart, and would undoubtedly prove a serious impediment, in combination with floating defences, to the entrance of an enemy's ships. But they are about 1,800 yards inside the narrowest part of the channel, as a glance at the portion coloured dark-blue on the chart (rippled in the plate) will show. By occupying the Warner Shoal, and the shoal opposite to it, near the buoy at the Horse Elbow, two forts might be constructed within 1,200 yards of each other, and these would have the double advantage of keeping the enemy further from the dockyard, and of commanding the main channel in a very superior manner. The Warner Shoal occupies an unmistakable position, and would probably afford good foundations for a fort; and I submit that it ought in any case to receive that which was originally intended for the Sturbridge Shoal; and there are two schemes in combination with it, both of which would be formidable and more or less satisfactory. Either the forts on the Horse Sand and No-Man's-land might be constructed as proposed, so as to form an equilateral triangle with the Warner Fort, with sides of 2,000 yards each, for the protection of this channel, or else the Warner and Horse Elbow Forts might be constructed 1,200 yards apart, with a third fort midway between the latter and the Langston Harbour Bar. The former arrangement would oblige an enemy to pass three forts instead of two in the main channel, and would more perfectly defend the shoals between the Warner Fort and the Isle of Wight. The latter would afford a closer defence to the main channel, and would protect the Horse Sand against vessels floating over it at high water. And this last is upon the whole that which I should prefer. The two forts, 1,200 yards apart, across the main channel, would be beacons, it is true, and beacons that would warn an enemy's vessels most effectually of the danger of attempting to get within 1,000 yards of them in any direction, if they made the attempt.

In combination with such a system of defence by forts, I can imagine nothing better in the way of floating defences, than six iron-clad steam-rams built expressly for the purpose, with a beak at each end, great speed, as light a draught of water as practicable, twin screws, manœuvring with the utmost rapidity, armed with the heaviest guns, each of which should be more than a match singly in these waters for any sea-going vessel. Stationed behind the forts, these rams would be ready to

make a dash, one after another, at any hostile vessels that attempted to pass them. Overwhelming them in detail as they came through, they would, by stopping the foremost ships, cause them to obstruct the passage more or less for the remainder, in reference to which operation I would recall to your memory the manner in which the Federal ships fouled each other during the attack upon Charleston. They would thus be able to retain the enemy's fleet under the fire of the forts, and prevent it from running past them at speed, which is the only means by which they could hope to succeed in getting safely through the channel.

The rams would thus form an obstruction of the best description for so wide an area, and they would be ready to co-operate with the forts wherever the enemy attempted to force a passage, either by the Needles, or by the main channel to Spithead, or over the Horse Sand, or between the Warner Fort and the Nettlestone Point battery in the Isle of Wight, though the passage at high water between the latter fort and batteries is so curved and intricate that no attack is likely to be made, or certainly to be feared, against such a system of defence, in this direction. This combination of steam-rams and forts would, I submit, effectually solve the problem which I have proposed, of keeping the enemy out without placing obstructions in the way of friendly vessels; and it would provide at the same time that defence for the inner waters which it would be impossible otherwise effectually to accomplish, against any hostile vessels which might chance to find entrance. The steam-rams would further be an admirable force for other purposes, and especially to act on the flank of any expedition against an undefended part of the coast east or west of Portsmouth; and indeed their presence at Spithead would be sufficient to prevent such an expedition from being undertaken in that immediate neighbourhood. The six rams at £250,000 each, and the three forts at £270,000 each, would cost, the former £1,500,000, and the latter £810,000, or altogether £2,310,000,—a large amount, but one which would be well expended. We should, at all events, if it were so spent, release our possible enemies from the temptation, and ourselves from the necessity, of engaging in mortar practice over the roads of Spithead.

Rear-Admiral Sir EDWARD BELCHER, C.B.: I venture to make a few remarks upon this question. In the first place, I am happy to find the engineers alive to the value of the navy. I must observe, in the outset, that with all these batteries which you propose to raise upon the Horse Shoe Sand, and other places, you are absolutely assisting the enemy by beacons. We are not to assume because we see 3½, 1¼ fathoms, and other depths marked on the chart, that that is the depth we should have with these forts, as if they were forts upon the land. There are 12½ feet more to be added at high water. The effect of building these forts would be that the tidal currents passing their tangents would cut deep channels round them, and instead of being, as now, upon the limits of No-Man's-land, and the Spit as it now stands, we should have a battery standing isolated *per se*, with a deep-water channel round it. If I was ordered to attack Portsmouth harbour, I could muzzle these forts immediately. Thus I would take eight or ten vessels; and there are gentlemen present who know that at a moment's warning we can, even at night, carry vessels through channels that were never believed to be passable, by means that we are able to adopt. We could chain vessels together, and with a flood tide allow them to drift athwart one of these forts, after setting fire to them. We could smoke the men out

of the batteries; or if we did not smoke them out, they could not see to aim the guns because of the smoke from the combustibles we could send in amongst them; therefore, I think all these forts which Captain Tyler proposes to build upon these sands are objectionable. If he could build them on a large space, at a distance from the edges of these shoals, so that the enemy could not approach them, I should not have so much objection to them; but by building them at the edge of deep water, it would enable the enemy to put, as it were, a necklace round them and smoke the garrison out. With respect to iron vessels to protect these places, I see no difficulty in building a floating battery which could be removed from point to point, and placed in position to attack the enemy wherever he may venture to anchor. You may give them 12 inches or 14 inches, or any thickness of iron you please, on the plans that I have proposed for arming batteries and arming ships with movable armour. You have only to form a cradle exterior to the vessel, and you may then add as much vertical iron as you please, plate over plate, and so render it perfectly impregnable at the water's edge. There is no necessity to build your vessels and encumber them with iron, so that they cannot move about. You can carry these shifting iron plates in-board, and when they are required for action it is very easy, by having the frame-work proposed outside, to put iron cylinders or plates one outside the other. In this way you can add 18 or 20 inches' protection on your floating battery. Such a battery would only be required in time of war. The vessels could be built, in the first instance, to bear a certain amount of weight on them, and the whole of that not immediately required could remain stored in Portsmouth Dockyard until it was wanted. Probably it would remain there till the day of judgment, for we should never be attacked if it was known we had such vessels available that could be armed in that way; therefore, I think a floating battery far preferable to any of these fixed batteries. Suppose an enemy smokes out these batteries, or places a blind of smoke round them, and passes in, you would at once lose the advantage of these batteries, whereas your floating batteries could move in and attack him. As to the forts at Sturbridge and on the Spit, a ship of war could pass them and take her position off Brown-down fort within pistol shot of the battery, and turn the men out. No single battery from that position would prevent any vessel from lying there and commanding every one of the works. Instead of forts it would be much better to have three or four of these floating batteries moored at Spithead. Even if the water is very shallow, you can construct vessels of small draught, and with a velocity of 12 knots, and thus move them about; whereas these forts, which cost so much, are simply beacons, which the enemy can avoid, and run past in the night. Even Captain Tyler's idea of floating batteries in support is a much better idea than that of trusting solely to the forts.

Lieutenant-Colonel COLLINSON, R.E.: Notwithstanding what has fallen from the gallant and well-known officer who has just spoken, I will venture to give an opinion that in putting a fort upon a shoal in such positions as those designated at Spithead, I do not think it will follow as an absolute necessity that it would cause such an alteration in the depth of the water round the fort as to lead to the effect which the gallant officer supposed. In the first place, it has not been proposed by anybody, at least it is not an absolute necessity of the proposition, that the forts should be put so close to the deep-water channel as to cause an immediate doubt upon that point. Secondly, if it was necessary to put them so close to deep water, it would be quite possible by addition to their foundation to cause such an impediment to the progress of the current round them, that it would absolutely tend to form a bar or shoal, instead of forming a deep channel, acting more in the character of breakwater and groins. They would naturally form a shoal round themselves, and so create a difficulty to the access of vessels to them. Then, again, I think the expedient proposed for blinding these forts and destroying their fire by smoke must be looked upon rather in the light of a temporary and casual expedient than as a regular mode of warfare for meeting a regular defence. It is one of those things which might possibly succeed in the case of an attack, but which also might very likely fail owing to some chance, mismanagement, or fault, such as occurred in the attack on Charleston harbour. I was also sorry to perceive by these remarks that there still lingers among some officers an idea that engineers entertain a strong feeling upon the subject of forts, as if it were a matter of dispute

between forts and ships. As far as I am aware, in all the discussions upon the subject connected with the defences of Great Britain, I do not think the engineers have put the question forward in that light at all, or have ever suggested that it should be placed in such a small compass as an argument between forts and ships, or between army and navy. I am sure the engineers and the whole army feel that the main defence of Great Britain must rest upon the navy. (Hear, hear.) Their only desire is to increase and assist the efficiency of the navy by providing such a permanent defence for our great sea arsenals that the navy may be enabled to employ itself more effectually at sea in its more legitimate sphere of action. Captain Tyler has shown us very clearly indeed the importance of forts in contributing to that object. The little *resumé* he has given us of the defences of Charleston has increased that opinion in my mind very strongly. Notwithstanding all the improvements that have been made in rifles, in rifled guns, and in armour plating, there still remain some great principles in sea defences, which probably will always remain so long as we use gunpowder for attack and defence. In land defences and sea forts you can always have a secure foundation for a fixed battery, from which you can get better practice, a thicker wall, whether of iron or whatever other material may be used, than you can use on the side of a ship, and a heavier gun with a longer range. Those are advantages which will always remain on the side of land defences. On the other hand, whatever the size of the ship, whatever its coating, or whatever its gun, there will always remain that inequality with regard to accuracy of fire, owing to the action of the water and the difficulty of moving a ship in the water on account of the tides and currents. Then there is the difficulty of fouling and the liability to accident to a greater extent than in the land battery. At all events, I hope for the future, after this paper, it will be understood that engineers wish to consider the defence of Spithead as a combined question of land and sea defences, of forts and ships, and not a mere rivalry between the two.

Captain FISHBOURNE, R.N., C.B.: As a naval officer I should be very glad to accept Colonel Collinson's proposition, and all naval officers should concur that there ought to be no difference amongst us, except the jealousy who should do his duty best. With regard to the plan suggested by Captain Tyler, I must confess that I have always entertained the same view which has been put forward by Mr. Brookes, that it would be desirable to have a line of defence in the direction of Langston harbour carried across the flat. I do not think it would offer any material impediment to trade; and I am sure it would be a great advantage for the purpose alluded to by Captain Tyler—the facility which it would afford for the repair of vessels. These vessels have to take out their gunpowder and a great deal of their stores before they can go into Portsmouth harbour; and with every increase in the size of ships that difficulty will be increased. The proposed plan would make an excellent harbour where vessels could repair; every facility would be afforded behind the barrier that would be run across from Langston harbour to one of these forts that are now building. I quite subscribe to the view put forward by Captain Tyler and Colonel Collinson; and perhaps I would be inclined to extend it a little more—that the progress of artillery has been, and will continue to be, more and more in favour of forts—arising out of the circumstances that any advantage which ships have hitherto had against batteries has been from their power of concentration of fire. By having two or three decks they have brought an immense number of guns to bear upon a few guns in return from a fort. The application of iron coating to ships has brought ships to one deck, and very few guns on that. Therefore the former disparity has altogether vanished. Another point has been brought out—long range. Now long range is of no value on board ship, for the want of steadiness of platform. A necessary condition of long range is a slow moving projectile, and a high trajectory. The consequence is that every infinitesimal motion which there is on board ship renders anything like certainty of fire from long range on board ship impossible of attainment. The descending angle is very great; there is no ricochet, the shot plumps in, the narrow deck of the vessel to hit. If you want to hit a distant object at all, you must have absolute steadiness. Whatever nicety of arrangement you have in the gun, all vanishes the moment you embark it on board ship. Long range from ships I contend is nonsense. One gun may be all very well for the occasional

circumstances in which ships are placed in smooth water, up harbours, where it is desirable to reach into a battery or into a dockyard, or where you have a large space to throw shells into, then it is of advantage. But in that case it should be a class of gun which would admit the use of spherical shot. For the ordinary service of a ship's gun, the shot ought to be round. Looking at the general question of fortification from a broad point of view, my idea is, that in acting upon the defensive, we are giving up our character, whether it is individually or nationally; that the true art of defence is effective offence; and I believe that is more consistent with our national character, and that no nation can so effectively carry out that principle as our own. It appears to me a proclamation of weakness the moment we begin to act upon the defensive. It is a feeling that will have a very strong influence upon other nations: when we begin to act upon the defensive, they will begin to think we "funk" and that is the very last thing we should encourage the idea of.

Sir EDWARD BELCHER: I just wish to make one observation; fact is better than theory. Hitherto in action our ships of war with mortars on board have done their work very well. Take the case of the "Etna," against Patras, which made the attack in a gale of wind. Again at the siege of Gaeta for 13 weeks we discharged every gun and mortar from floating* batteries; we had no land batteries bearing on the sea-faces; and we threw our shells with the utmost precision, even into houses suddenly designated. If we cannot fight at sea, or if the enemy cannot do, as we can do, in attacking Portsmouth, why care about Portsmouth? for, from what is stated, they would not be able to hit it.

Captain TYLER: I need not detain you at any length in replying to the gallant officer who spoke first. He is afraid of these forts acting as beacons. I thought I had pretty well disposed of that question when I said the forts would be rather beacons of warning than beacons of safety. But independently of forts there are already beacons enough. There is no difficulty in any foreign vessel finding its way into Portsmouth harbour. There are beacons on Portsdown Hill, beacons at Gillkicker Point, beacons over the whole harbour; and as the Commissioners state, if the buoys and lights were removed, the enemy's vessels would have no difficulty in finding their way in by the soundings. With regard to the question of smoke, the gallant officer proposed instead of forts to moor floating batteries in their places. I do not see myself why the smoke should take more effect upon forts than it would upon floating batteries.

Sir EDWARD BELCHER: Not to moor them; to anchor them *pro tempore* where required. *They* can *move* to another part when the smoke vessels arrive.

Captain TYLER: Then when the smoke arrives the vessels are to run away from it, so that the difficulty will be very easily overcome; the enemy will have nothing to do but to bring out a few smoke-pots and these vessels will turn tail.

Sir EDWARD BELCHER: Divide right and left, and get out of the way of it; avoid them.

Captain TYLER: That objection is one that will not apply as regards forts: the forts will not be driven away by smoke. If the smoke does come, and that will depend upon the way in which the wind blows, the forts will do their best to fire through it; and if a stiff breeze should be blowing, the smoke will not remain long.†

The CHAIRMAN: It remains for me to thank Captain Tyler for the able paper he has read.

* None exceeding 200 tons. Twenty-six mortar vessels, carrying 10 inch and 13 inch mortars. Thirty-six gunboats, carrying 68-, 32-, and 24-pounders.

† The Federals have not yet smoked the garrison out of Fort Sumter. Any attack in which smoke is depended upon is liable to end in smoke.—H.W.T.

LECTURE.

Friday, February 19th, 1864.

Colonel P. J. YORKE, F.R.S., in the Chair.

THE ERRORS OF THE RIFLE.

By Captain G. B. V. ARBUCKLE, late 57th Regt.

In offering some remarks on the errors of the rifle, I wish to say, that the observations about to be made and the points touched upon, which may improve the scores in general both of the soldier and the volunteer army, are offered to your notice for this reason, chiefly, that they do not appear in any printed form. There are some to whom my remarks will not be new, viz., the old steady and practised hands, but there are many young aspirants for honours at Wimbledon and elsewhere to whom they will be new; and although I obtained a certificate of the first class at Hythe, it is not on that account I would venture to put forward my opinion, but there are some points hitherto not touched upon, which I hope will appear worthy of consideration.

The points I shall remark chiefly upon are these:—1st. How it happens that the champion shot of one year seldom stands A 1 on the list another year. 2ndly. The importance of calculating very minute or decimal errors.

If shooting were a mechanical operation, it would be perfect. The rifle would be (as it often is now) perfect, the rest from which it is fired would be perfect, on a perfect foundation,* &c.; as all this cannot be, it is endeavoured to make it as nearly approaching a mechanical operation as possible, for which reason the importance of position drill is so much insisted on.

The fault, then, may be of two kinds—

When the rifle is correct,
When the rifle is incorrect.

In the first case, if the rifle is correct, the fault of a bad score must

* When Her Majesty the Queen fired the first shot at Wimbledon the trajectory was not allowed to depart from the bull's-eye, but the rifle required constant watching, as the platform sank gradually with the weight upon it, although so little.—G. B. V. A.

rest with the rifleman. In the second case, the errors will be ascribed to the rifle, and will continue to manifest themselves until the rifle is corrected, but these cases are so rare that it would be as well to confine our observations to the first case; when the rifle is correct. When it is so, it is surprising what a number of points must be attended to, in order to ensure accuracy, and, indeed, unless they are attended to with the utmost care, inaccurate shooting will follow as a positive certainty; these items, on a moderate scale, amount to fifteen at least, and unless all of them are guarded against, no good shooting ought to be expected.

It is for this reason, viz., the difficulty of attending to *all* the minutiæ, that no one man, however good one day, is found as a matter of certainty, good the next.

It MAY be so, and if the operation were mechanical, it would be so; but we have only to look to the Wimbledon reports, to see how uncertain rifle-shooting at present is. We there find Mr. A., who won the first prize of 250*l.* and the gold medal at one time, enters for other prizes and is third or fourth. The champion of one year, makes a very poor figure the next; the winner of prizes one day, makes very indifferent shooting the next.

Mr. B. wins a magnificent cup at one range, and on the *same* day, with the *same* rifle perhaps, comes in 5th or 6th in another match at another range; in short, as to certainty there is nothing like it. It is true you may pick a group of good shots, and they can be depended on to make much better practice than another group not so selected; but of the first lot—the group of very good shots—the *crême de la crême*—take for the sake of argument the eight best shots of England, and that a stranger looks over the score: One is first—one last, and between the two what a variety of comparisons may be made, and yet they are all good. If the first should be accounted very good, and the last very bad, a stranger might class them as follows:—

1. Very good shooting.
2. Good.
3. Verging to good.
4. Tolerably good.
5. Verging to bad.
6. Indifferent.
7. Bad.
8. Very bad.

In the same manner if the eight best shots of Scotland are taken. The first may be reckoned the best, and the last of the eight the worst.

and yet these 16 have done wonders with the rifle, being, indeed, the champion 8 of the two countries. But if the same eights were to shoot in a week following at the same range, under circumstances identically the same, the last would possibly be first, and the first last; or if this should NOT be the case, then the first would not remain first, nor would the second remain second, nor the third third, but places would inevitably change, and so on to the end of the chapter. Why, then, is this so? Unquestionably because of the almost insuperable difficulty of getting all things right at the right moment.

Let us consider, then, how many things are to be got right, without

which it is hopeless to make a good score, and then, if it is in the power of the rifleman to have them all in good order.

First of all we will assume the rifle is correct, then as the

1st necessity.—It is undoubted that the quantity of powder for each charge must be the same, for if too much, it will throw the ball too far; if too little, too short; thus the 100th part is sufficient to do this at a long range.

2nd.—The powder must be of the same strength; it should be weighed by the person firing himself, and from a large quantity well mixed, so as to ensure uniformity.

3rd.—If the first two are attended to "then," it must be kept dry, for dampness weakens it. The necessity of this will be shown, when the decimals of error are considered. Here, then, are three points connected with powder to begin with.

4th.—The bullet must be the same weight; for if too heavy, it will fall short, if too light, will be propelled too far. (The charge being always the same).

5th.—It must be compressed, not cast. Every bullet that is cast has a hollow in it, caused by the contraction of the metal. All metal, whether a bullet of lead weighing ½ oz., or a crank of iron of 50 tons, if cast, has a hollow in the centre, caused by the contraction of the metal, which nothing can prevent.

6th.—The grease used is of importance, and ought not to be of an oily nature, for if so, it wets the powder, and *so* weakens the charge.

7th.—The wind must be most carefully considered, for if blowing straight against the rifleman, it retards the flight, and the rifle will require more elevation; if towards the target it augments the flight, and less elevation is required. If the wind is from the right, it will throw the ball to the left, if from the left *vice versâ;* but if this only had to be considered, it would be little indeed. There is *every variety* of the above, and then allowing this, there is every change of distance. What is allowed for 500 yards will not do at all for 600, and unless the wind is most carefully attended to, it is useless to expect good practice; indeed, while shooting ordinarily, as at Wimbledon, the flag must be watched, to show the force of the wind at different times, even of the same day. These, then, are some of the difficulties of rifle shooting; but it may be said are there more? I fear the list enumerated is only a part. If the rifle is correct as a 7th necessity, it must be held with sights perpendicular. If it is so, it must be pointed exactly correct, the 8th point to be attended to.

Allowing it is a different matter to have all the above items kept in view, and having them so, unless the following are attended to also, the rifleman may as well stay at home, and better if he has to pay for entries.

9th. The eye must be correct—Firing from a rest, and having hit the target three times in succession, the fourth shot strikes just on the edge of the target, and 3 feet from the centre to the right—(it will be granted such an error often occurs)—all the circum-

stances being the same, powder, bullet, &c., an error of the eye must be the cause; the fore-sight was pointed to the right, and hence the bullet struck to the right. The question is *how much* was the fore-sight pointed to the right or in error? If the distance was 500 yards, it will be found by calculation the sight was pointed $\frac{72}{1000}$, say $\frac{7}{100}$ of an inch in error. In like manner if the fore-sight was pointed $\frac{7}{100}$ of an inch to the left of the centre, the bullet would strike 3 feet to the left; if $\frac{7}{100}$ too high, it would carry 3 feet too high. If the distance were 1,000 yards, and the error 3 feet, then the error at the time of firing would be half the above, or $\frac{36}{1000}$ inch. The larger quantity $\frac{7}{100}$ is very small; how much smaller the half of it. For this reason the sights should be regulated according to the eye of the observer, and as fine as the rifleman's eye-sight will permit. These quantities, the $\frac{7}{100}$ of an inch, and the $\frac{36}{1000}$, although so very slight, need not discourage any aspirant for rifle honours, for although small, the eye is capable of appreciating and regulating them too. One distinguished officer of volunteers struck the bull's-eye 18 times out of 20 successive shots. Here all the items having been carefully attended to, as shown by the result, the whole would have been useless, had not the eye been perfect also; indeed its delicacy is marvellous, and its accuracy almost incomprehensible, save when we consider Whose handiwork it is.

10th. Uniformity of bullet must be preserved.—It will be observed that the top of the bullet is of a uniform shape. This is in order that the resistance may be uniform. This uniformity must be retained when the bullet is rammed home; it is manifest, therefore, that it must not be struck with the ramrod, but gently pressed into its place in the barrel, pressed quite home, so that no space be left between it and the powder.

11th. At least five minutes should elapse after firing before loading again, for this reason, the last discharge has heated the barrel, that heat keeps the grease more liquid than when cool; if liquid the powder gets damp, and, therefore, weaker.

12th. A most prominent cause of error, and one which spoils many a man's good score, is the want of a proper position. At Hythe I observed an excellent shot, in the same squad as myself, hit the target 20 times in succession at 500 and 600 yards, and not count a single point. Every shot was a ricochet. Watching carefully, I found out his error and corrected it. His left arm was not kept

The error at any distance may be found thus, putting the error at $\frac{1}{10}$th of an inch, and the range 500 yards, if to the right or left, elevation or depression,

As the distance from the eye to the fore-sight pointed wrong, or $\frac{1}{10}$ in error,—say 3 feet or one yard is to its error $\frac{1}{10}''$—so is 500 yards to its error, or,

1 yard : $\frac{1}{10}$ inch : : 500 yards : 50 inch or 4 feet 2 inches.

If 1,000 yards, and the error $\frac{1}{10}$, then

1 yard : $\frac{1}{10}$ inch : : 1,000 yards : 100 inches, or 8 feet 4 inches.—

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perpendicular to the knee; if it is so, and held firmly, the muzzle cannot fall at the explosion, but if the arm is at an angle it is bent downwards by the kick of the gun, which it cannot be in the first case. Being bent down *ever so little*, as I showed, by the decimal error, the ball will almost invariably ricochet. A familiar instance, illustrating what I mean, is this:—If two ramrods are placed perpendicularly, one on the top of the other, and kept so, they would support a considerable weight; but if the least out of the perpendicular, they would support no weight; so, if the arm is really perpendicular it cannot be compressed, but if not, it is invariably bent downwards, as shown practically, though not felt by the rifleman firing.

13th. The rifle, it need hardly be stated, must be kept clean; if fastened to the stock with bands as the Enfield, these bands must be carefully screwed, for if too tight they compress the bullet, retarding its flight and causing ricochets,

14th. The pull of the trigger is important and should be as light as possible, consistent with safety—6 lbs.-pressure has been considered by the military authorities as affording these advantages. That may be necessary for private soldiers, but it is far too great for people in general; it is said a less pressure is dangerous, but so is gunpowder and everything connected with it; a light pull simply requires greater care.

It would be greatly to the advantage of riflemen if a less pull of trigger and also a rest for the rifle were allowed. It is to be hoped that many years will not pass before rests will be granted. They are simple, easily carried, not expensive, and of the greatest use. With our small army, efficacy is the one great thing to look to.

Without venturing a political opinion as to Denmark, had circumstances obliged us to send an army thither, it *must* have been a very small army indeed, compared with that of Austria or Prussia—of great consequence then, that the men composing it should have been as efficient as possible.

At present the great delay in firing is all caused by the difficulty of getting a proper alignment; with a rest it is obtained immediately at all kneeling distances, therefore a *very great* amount of time would be saved—a most important item; an indifferent shot who misses the target 15 times out of 20 at 400 yards without a rest, will hit it 15 times out of 20 with a rest. There is no difficulty about the matter, and the improvement it would effect in the shooting would be very great. Ramrods that could be used as rests, might be attached to every Enfield rifle now in the service at a cost of 1*s.* each.

This suggestion has been approved of by rifle instructors in the regular army, and feeling perfectly confident of its usefulness, having seen it tried, I trust others will try it also, so that the subject may be, to use an expressive modern term, well ventilated; in a few years it may be considered worth attention, and in a few more perhaps adopted. The good shooting in the returns of our army would be increased from 50 to cent. per cent. I am obliged to mention years, as history shows the above statement regarding the slowness to

adopt improvements to be true; one of the most useful reforms, viz., that from flint locks, with the troublesome powder-horn, &c., to percussion caps, took no less than 27 years to accomplish. With continental armies, so vastly superior to ours in numbers, this *little* island should have its *little* army as perfect as circumstances will allow. It is also the greatest humanity to make weapons of war as deadly as they can be made, for, although paradoxical, it is yet true that the more deadly the weapons used in war, the less is the loss of life. That this is true we have only to look to history: at the battle of Flodden, on the Scottish side only, the king and 10,000 men were left dead. At Waterloo, where gunpowder was used, the loss of the whole allied army was less than 8,000 in killed and wounded. Although numbers must of necessity have a great bearing on the question, it is also a question of spirit, and that spirit must be inspired by the confidence of men in their leaders, and that confidence must be inspired by the perfectness of the details of an army in all parts. What I mean is this, if numbers were to be considered the chief necessity, then it would only be necessary to bring 200,000 of one nation to conquer 100,000 of another; we know this not to be the case, but as we have not got men, the endeavour must be to make up for the quantity by the quality.

At the annual matches at Wimbledon a gradual process of sifting goes on, the residuum being a few winners only. Of the immense numbers who compete, those who appear are the best from many localities, indeed everywhere that a volunteer corps exists. Of the 250,000 volunteers, each corps sends forward those men who have proved themselves the best shots in their own neighbourhood, so that Wimbledon may be said to represent the *élite* of the riflemen of the day. And of them, how many go back empty, any one may see by referring to the report of the proceedings at the meetings. The reason undoubtedly is, not the carelessness of individuals, but their not being acquainted with all the minute details necessary for success. If it should be said, there are 50 prizes and 250 men to compete, therefore 200 must be losers, that is true; but as to the winners, they are not 50 of the 250, but 40 or less, some men taking two, three, and four prizes. My endeavour in this paper is, to impress upon riflemen generally the importance of *little* details, without which *great* results can never be obtained; and in summing up the different points, probably no one will be found to dispute this. That although a prize *may* be won without their being alluded to, still every one competing ought to bear in mind:

1. That the powder ought to be of the same weight.
2. Weighed from a large quantity to insure uniformity.
3. Must be kept dry.
4. Bullet of the same weight.
5. Compressed, not cast; as all cast bullets are eccentric in their flight.
6. Grease of suitable nature.
7. Proper allowance for wind.

8. Rifle must be held with sights perpendicular.
9. Correct alignment.
10. Bullet pressed home, not struck with ramrod.
11. Not to load when the barrel is heated.
12. Proper position, forearm to be perpendicular to knee.
13. With Government rifles to see the bands are not too tightly screwed.
14. Pull of trigger to be as light as allowed by regulation.
15. Never fire unless you can snap a cap without the least motion, except of the finger (and the eye steadily fixed on the mark); if you cannot do this you are not in good shooting order.

Having only graduated to a certain extent, there may be points of equal moment not touched upon, and the Institution will be glad if any one would point them out. Having felt the importance of this knowledge, particularly that of decimal errors, and their having been pointed out, it will give me much pleasure to hear that the subject engages attention.

LECTURE.

Friday, March 4th, 1864.

Colonel P. J. YORKE, F.R.S., in the Chair.

THE APPLICATION OF ELECTRIC TELEGRAPHY TO THE STEERING AND GENERAL MANAGEMENT OF A MAN-OF-WAR.

By Lieutenant A. H. Gilmore, R.N.

The object I have in reading this paper before the members of this Institution, is to explain the construction, action and application, of the electric telegraph to the working of a ship. If in the course of my explanation, which is written for my practical, and not my scientific hearers, I should touch too much upon the first principles of electricity, and enter a little into detail, I trust those present who are better acquainted with the science, will forgive me if my lecture prove a little tedious.

It is now some seven years since my late brother brought to the notice of the Admiralty, the means of applying electricity to conveying the necessary orders from forward to the helmsman in dark, windy nights, when navigating narrow intricate channels; and submitted to their Lordships an electric dial for that purpose. This dial had been used on board the "Wonga Wonga," in Australia, and had proved of infinite service on many occasions. After the lapse of some years, and after my brother's decease, their Lordships allowed my partner and myself to fit our steering apparatus to Her Majesty's ship "Resistance." In 1862, we fitted to that ship the very dial that had been used in the years 1856–57, and which, since then, had been held in reserve, ready for the day when the order should arrive for it to be fitted to one of Her Majesty's ships. That order did arrive; and that very dial, with certain alterations and improvements, was at last fairly launched on board a man-of-war. There is an old saying, "Keep a thing seven years, and a use is sure to turn up for it." We have here the verification of that old saw.

Their Lordships were informed, that although this individual instrument was only applied to steering purposes, still a further application of the same means would enable us to communicate to any part of a ship with which it would be necessary for the captain to have immediate and unerring communication.

I see here many naval officers; to them it will be unnecessary to describe the difficulty that exists in conveying at night, in a gale of wind, or even in a strong breeze, or when steam is blowing off, an order by word of mouth from the fore-bridge to the wheel. In long ships it is necessary to place men at intervals on the deck, to pass the word along. The eddy winds about the deck whisk the words away from the speakers' mouths, and the order frequently arrives at its destination mutilated, or is lost altogether, and has to be repeated. Such mistake of an order might have caused irreparable mischief and loss of life. The time lost, whilst the order was being repeated, might have just been of a sufficient interval for mischief to occur, and "too late, too late" would be the reply, when, alas! the order itself had arrived too late. Any sailor, and many travellers can call to recollection the close shaves they have seen, from the helm not being "given" in time; or from the order having been misunderstood, the wheel having first been put the wrong way, and afterwards having to be put right in a moment of emergency. Take the following for instance—the night is dark and full of gloom, the gale is whistling through the rigging, the sea is dashing against the side in crested waves; the range of sight is limited to a few fathoms, and the range of the voice to a few feet; when towering on your weather quarter a huge mass tearing before the gale, emerges from the gloom, bearing down upon you with all the force of destruction; "hard up," is the order shouted, and if luckily the order is heard and acted on, the stranger flies past you, and the heart that had been in your mouth settles fluttering down into its accustomed place. But if the order had not been understood, what then? Look to the wreck chart, or read the list of missing vessels, or even the cases of collision tried in the Court of Admiralty. Imagine another case: you are running up channel before a south-wester, the look-out man cries "A light a-head," you see a small vessel—a fishing smack crossing your bows; put your helm over at once, and you clear her. The helm must be put over immediately or you are upon her, and every soul in the little craft will be lost; your heart again beats tumultuously with fear for those poor fishermen. If the order is not instantly acted on, or if it be misunderstood, a watery grave *must* be their lot.

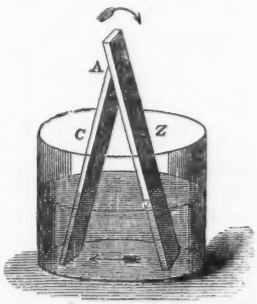
It is needless to multiply cases in which a moment's hesitation or a single error would be fatal, especially in fleet sailing. It *cannot* be denied that in the present condition of naval warfare, a means of instantaneously transmitting orders from one part of a ship to another, is imperatively demanded. Rapid, consequently successful manœuvres, can only be carried out by rapid and correct transmission of orders, and their equally rapid obeyance. If ships are to be used as rams, it is imperative that in giving collision, the ram be steered to a nicety, and her course altered instantaneously. If also, as Admiral Sir G.

Sartorius proposes, large guns are to be put into small vessels—these vessels, forming as it were, locomotive gun carriages—the elevation and depression of the guns being obtained by elevating screws or quoins, whilst the training of the guns is to be effected by the horizontal movement of the vessel's bows to port or starboard; how necessary that the training should be gained with the utmost rapidity, so as to cover objects in motion. The double screw is a great step towards this end, but even the double screw is useless, unless we possess some means of instantly sending the proper orders to the engineers. Also in manœuvring ships, a means of communication is essential, not only between the captain and the helmsman and engineers, but equally between him and the cupolas, divisions of quarters and magazines; so that, when the order is given to the helmsman to alter the helm, instructions would be sent to the engine-room requiring the engines to co-operate in the movement; to the officers in charge of cupolas to train the cupolas as the ship comes round; to the officers of broadside batteries to lay their guns on the requisite bearing; and to the magazines to order the most destructive charge suited for the time to be passed up.

The particular telegraph I am about to describe is applied primarily only to steering purposes; but I have here a ground plan of the key-plates of a larger telegraph, by means of which the officer in command is in communication with wheel, engine-rooms, cupolas, or divisions of quarters and magazines. The principle contained in each instrument being nearly the same, a description of one will lead to a thorough comprehension of the whole. The electricity employed in this apparatus is commonly termed voltaic electricity, and is the production of the action of a galvanic battery.

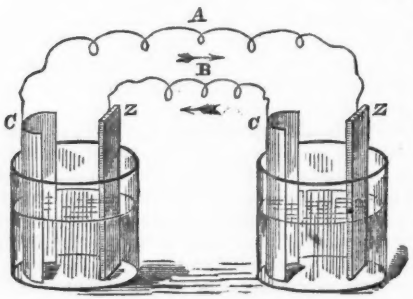
If we take a piece of zinc Z (Fig. 1), and a piece of copper C, and place them in water, so that the submerged parts shall be separated, whilst the upper parts rest against each other, we have a simple battery. The oxygen of the water attacks the zinc, chemical decomposition takes place, and a current of electricity is generated. This will continue as long as the upper parts of the metals are in contact or connected, but the moment they are separated, all action ceases. Of course such a battery as this is very weak, the zinc becomes coated with oxide of zinc, which being insoluble in water, stops all chemical action. A little sulphuric acid added to the water, however, obviates this by turning the oxide of zinc into sulphate of zinc, which being soluble in water allows the chemical action to continue. As long, therefore, as there is any zinc to be acted on and eaten away, and any sulphuric acid to combine with the oxide formed, a current will continue until the solution becomes saturated with sulphate of zinc, when, by a pecu-

FIG. 1.



liar electrical process, the metal zinc becomes deposited on the copper, and stops further action. To obviate this, it is usual to place the zinc in a solution of sulphate of zinc, and the copper in a solution of sulphate of copper, separating the two by a porous earthenware partition, when copper is deposited on the copper plate, which of course does not interfere with the generation of electricity. Such a battery with only a pair of plates, is of course only of small power, and can only work through a short distance, any addition to the length of the connecting wire A (or conduit pipe) tends to reduce the power, but, on the other hand, by increasing the number of cells we can make a battery of sufficient power for any required purpose.

Fig. 2.



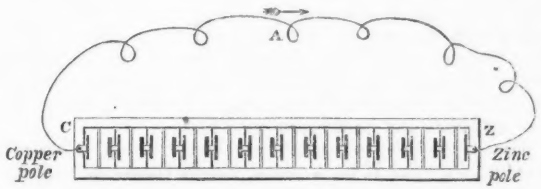
Let us take two vessels similar to that in Fig. 1, and charge them similarly, but instead of leaning the metals against each other, connect the zinc in the one vessel with the copper in the other by means of copper wire, as in Fig. 2.

We have now doubled our battery power, and so on, every cell we add and connect we increase the power.

So long as the cells are connected by the wires, the current generated will continue to flow, but if the wires be broken or disconnected the current at once ceases. The current is always supposed to flow from the zinc, through the liquid, to the copper, and thence by means of the connecting wires, or "circuit," as it is technically termed, back to the zinc. Thus in Fig. 1 it is shown by the arrow to be flowing from right to left, but by simply altering the connection of the wires it can be made to flow the reverse way. This flowing of the current is merely an arbitrary method of conceiving the action of the current, and though probably not theoretically correct, is practically the most useful method of describing the force generated by the battery. As it would, of course, be very inconvenient in practice to employ such cells as in Figs. 1 and 2, a more compact and convenient battery is used. It is a trough made of teak, divided into a number of partitions or cells, answering the purpose of the vessels employed in Figs. 1 and 2. These cells are again divided by partitions to keep the copper and zinc solutions separate. Fig. 3 shows the battery in question. It is called a 12-plate sulphate battery, there being sufficient cells to accommodate 12 pairs of plates. When the plates are laid in as shown, and the two sides, C, Z, brought into contact with the wire A, we have sufficient battery power to work an instrument within a short distance. Such a battery, if moderately though frequently used, will retain its power for a considerable time—ordinarily from six to eight

months. Excessive use causes, of course, a proportional consumption of sulphate of copper; on the other hand, if allowed to remain idle, the plates become covered with dirt or fur, and the action of the

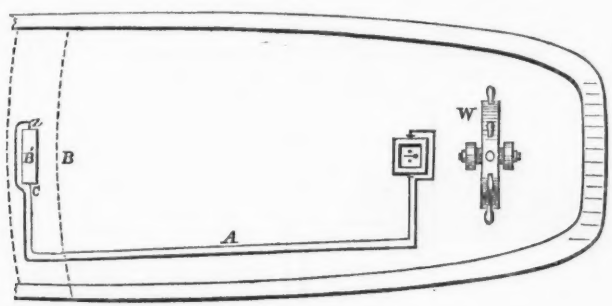
FIG. 3.



battery is destroyed, so that all that is required to maintain an efficient battery power is to see that the plates are cleaned from time to time, and that due supply of sulphate of copper be kept in the copper cells, and the connections perfect.

The battery being constructed, we will next consider the means employed to convey its influence to distant objects. A piece of wire (as shown in Figs. 1, 2, 3,) generally performs this office. The wire employed on board ship is copper covered with some insulating substance, such as india-rubber or gutta-percha. It is thus coated or insulated to prevent the different wires coming in contact with one another, or with the wet planks or water, as in either case the electricity would be dispersed. These wires convey the electric current as water-pipes convey water, or gas-pipes gas; so that if allowed to come into contact with water, or with one another, they would be as inefficient as leaky pipes, water being a non-electric or conducting substance, and allow all the current to escape. If we require to send an electric current from the bridge B to the wheel W (Fig. 4), we lay a wire (A) between these points, at B we join it to battery B at C. It

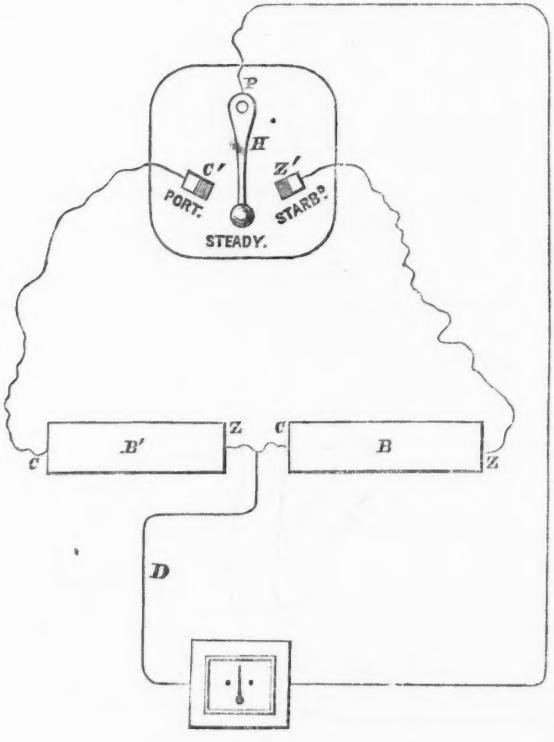
FIG. 4.



is, however, necessary to complete the circuit, that is to bring another wire from W to B at point Z. On land the earth is used to complete the circuit, but on board ship a return wire is necessary. Thus we have a continuous current flowing from B through the wire A to W, and if we inserted a sufficiently delicate instrument at W we should be enabled to read the signal transmitted from B. This current, and therefore the signal, is continuous as long as the wires are kept in connection with the battery, and is always the same if the current continues to flow in the same direction; but it can be interrupted if the wire be disconnected, or reversed if the connections of the wires be altered. To be constantly connecting and disconnecting by hand would be a tedious and unpleasant operation.

We have, therefore, an instrument called a key adapted to this purpose (Fig. 5). Let H be a metal handle (brass or copper) free to

FIG. 5.



work to the right or left (port or starboard) on a centre P, and so governed or regulated by springs or other means that it shall, unless designedly moved, be held as in the Fig. at steady.

From the Z of battery B join a wire to block Z′, and connect the other pole C of the battery to the return wire D. In the same manner connect the other poles of battery B′ to the block of the key C′, join the line wire A to the key handle H at P; the handle now communicates with the line A. In the case before us, then, we have, when the handle is at "port," the course of the current as follows: From battery B′ through its wire C to the contact point C′, upon which the handle is resting in full contact, thence into the handle and line wire, and so to the instrument I, and back by the return wire D to the other pole of the battery B′. If we now bring the handle over to "starboard," we get an opposite current to that when the handle was at port, the battery B being connected up in the reverse manner to battery B′. The reversal of the current could easily be accomplished with the key with one battery only, but a second battery is adopted to simplify the construction and reduce the number of points of contact, which are always sources of mishap. It may be as well here to call attention to the necessity of keeping the points of contact Z′ and C′, as well as the points of contact in the handle, clean, otherwise the current will not pass. A piece of sand-paper will remove any dirt or crystals of salt that may clog them.

We now come to the instrument; the principal features of which are, viz., an indicator on the face of the instrument, moving in accordance with the index handle, H, on the fore bridge or station, and indicating port, starboard, or steady, as the operator desires. 2nd. A bell or gong sounded at either signal to port or starboard, thus calling attention doubly, by the deflection of the indicator and the sharp sound of the bell which is inside the instrument facing the wheel. The construction of the instrument is simple enough, it still, however, requires a little consideration of the power of electricity as regards magnetism, to understand it thoroughly.

The influence of a magnet on iron or steel, is too well-known to need comment, the action of the electro-magnet is not, however, so well-known. If we take a piece of soft iron, and wind round it a copper wire covered with silk, to prevent one lap of the wire coming in contact with the other, and then join the two ends of this wire, one to either pole of a battery, so that the electric current may pass through the wire, and so round the soft iron core; the core at once obtains magnetic powers, and becomes an electro-magnet; and if we bring it into proximity with a delicately hung magnet, it will attract or repel the magnet according to which current—positive or negative—is passing through the coil.

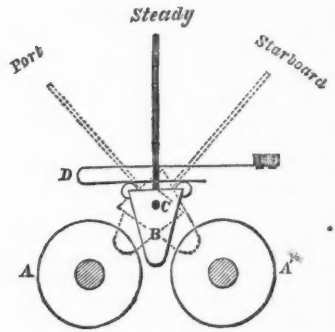
Fig. 6.

Thus, in Fig. 6, suppose A to be an electro-magnet, of which D

is the iron core, on sending a positive or copper current through it, we shall find that B will attract the north pole of a magnet, whilst C will repel it. On sending a negative or zinc current through it, the case will be reversed, C will attract the north pole of the magnet, and B repel it.

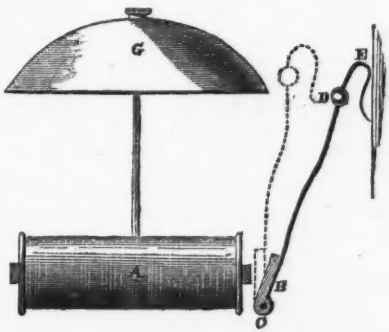
Let a pair of small coils, A A, be arranged as in Fig. 7, a magnet, B, working in a centre, C, between them, on passing a current through the coils, we shall find the magnet assume one of the dotted positions in the Figure, and if an opposite current be introduced, the reverse will be the case.

FIG. 7.



The movements of a needle or indicator attached to this magnet, will, of course, correspond to the movements of the magnet itself. It will be seen at once, that these two movements provide us with the signals, port and starboard. We have, however, a third signal, steady, to arrange; gravitation will help to give us this, but to insure a permanent signal, additional precautions have been taken. The magnet B has been provided with two small rollers, one at each of the upper corners, a small spring, D, presses against these rollers in such a manner as to retain the magnet, and consequently the indicator, in a perpendicular position when no electric current is passing through the coils. But the attraction of the electro-magnet is sufficient to overcome the pressure of the spring on the rollers, and deflect the needle. No sooner is the current withdrawn, than the spring causes the magnet to assume its vertical position. This spring is so arranged, that its readjustment is easy, should it ever get out of order. Thus we have the three signals, required, viz., port, starboard, steady, by means of which, in accordance with the following code, the officer in charge can order the helmsman to give any amount of helm, from "3 spokes" to "hard over." The movement of the key-handle not only causes the indicator to deflect, but also a bell to strike (Fig. 8) thus doubly calling attention; supposing this is the code adopted, one movement of the handle, which causes one deflection of the needle and one stroke of bell, means 3 spokes; two movements of handle, 6 spokes; three movements, 9 spokes, and so on. The handle moved rapidly several times, causes the needle to deflect, and the bell to keep ringing, and would show that the officer was in a hurry, and wanted the helm hard over short. We will now consider the action of the signal bell. This is effected by means of the same electro-magnet that is employed to deflect the indicator. A in Fig. 8, again, represents the electro-magnet; let B, the armature, be a

Fig. 8.



piece of soft iron working upon a centre, C, with a small rod and hammer D, fixed to it, and dependent upon its movement. E is a piece of wire passing through the head of the hammer to regulate the distance the armature is to be kept from the magnet; on a current passing through coil A, the armature will be at once attracted towards it with a quiet, sharp movement, and the hammer, D, if properly regulated, will strike the bell, G, and remain in that position as long as the current continues; on that ceasing, the hammer immediately falls back to its place of rest, until another current is sent. By this means, in conjunction with the indicator, we can order the helmsman to give any helm. For instance, if it be pre-arranged that each deflection is to mean three spokes, and twelve spokes, or a "turn of port-helm," is wanted, the officer in charge moves the handle four times to port, the indicator facing the helmsman deflects four times, the bell strikes four times, and the helmsman immediately gives a turn of port-helm.*

You will observe that the action shown in Fig. 8 is not the same as in Fig. 7; here (Fig. 8) the armature being merely a piece of soft iron, is attracted to the electro-magnet by every current passing through it, no matter whether positive or negative. In Fig. 7 the movement of the magnet is entirely dependent on the nature of the current employed, a positive current attracting it one way, and a negative another. The return signal by which the helmsman repeats the order received by him, to the officer in charge, is constructed precisely in the same manner as shown in Figs. 5 and 7.

It will be easily seen how the application of the same principle, can be applied to the conveyance of orders to any part of the ship. With a bell to call attention, and an indicator to point to the word of command, we have all that is necessary. The great object we have had in view in constructing this instrument, has been to make it as simple as possible; so that it can be easily comprehended, and in case of derangement, repaired by any ship's armourer.

The principles on which it is worked, and which I have detailed to you, are easily acquired, and the mechanical construction of the instrument is of the simplest nature. It may have appeared to those unacquainted with the science of electricity, that the minutiæ into

* As long as the key-handle rests at port the indicator points to port, and the helm will be kept to port.—A. H. G.

which I have entered are complicated and dry; but the principles enunciated are far more simple than those required to comprehend the compass, and *infinitely* simpler than the action of a steam-engine.

Electricity is but in its infancy. It is impossible to say to what purposes it may not be applied. When abroad it transmits our thoughts and wishes from distant lands to our dear old England. It guides and protects us in our rapid journeys along the iron highways. In Brussels, amongst other places on the continent subject to intense cold, whole streets of skeleton clocks may be seen keeping time by means of a guiding clock, through the agency of electricity. From the merchant's country house to his office, from the hall to the stable, from the dining-room to the kitchen, from the Admiralty to the Commander-in-chief of the Channel squadron, it alike attracts attention and conveys commands. It silvers our plate, and copies our engravings; it alleviates pain, and cures disease. Indeed, there are few purposes to which it is not applicable.

Its application to naval purposes is not its latest novelty, nor its least utility; and it is hoped that its adoption into Her Majesty's navy will lead to its ultimate introduction to navigation generally. I may here state, that we have our steering apparatus on board the following ships of the Royal Navy: Her Majesty's yacht "Victoria and Albert," the iron frigates "Resistance," "Hector," and "Prince Consort," the "Orlando," 50, and the "Orontes."

I and my partner, Mr. Preece, to whom I am indebted for electrical improvements in the apparatus, claim no merit for the invention itself. But we *do* claim priority in its practical introduction to naval purposes; and we take to ourselves the credit of having been the first to introduce to the Lords of the Admiralty the means of steering and working a ship by the electric telegraph.

The subjection to which science has reduced lightning, which is only electricity in a high state of tension, is a subject worthy of deep contemplation.

Imagine the look of amazement on the face of Old Benbow, Peter Parker, or other of the ancient mariners, if in the midst of a terrific storm of thunder and lightning, the wind howling, and rendering inaudible all words of command; imagine Benbow's face, if at the moment a consort's foremast had been struck by the electric fluid and shivered, some one had bawled into the old gentleman's ears through a speaking-trumpet, the future improvements of science. How Sir W. Snow Harris would insert a ribbon of copper down the masts and quietly lead this *dread* enemy into the sea, and there harmlessly disperse it. How, again, in future years science would hold prisoner this mortal terror, and make it work like any slave obedient to the motion of a finger. How, again, in a few more years, when England had spread her empire from sun to sun, *iron* ships three times the length, and six times the tonnage of the gallant old "Breda" that Benbow so nobly fought, would traverse the ocean without sails at the rate of 16 knots an hour. How, in the darkest night and in the fiercest gale, amidst all the confusion of a tremendous action, this imprisoned and fettered lightning would convey with its own immeasurable swiftness,

and the most perfect accuracy, orders from the captain to any part of the ship. What would have been the old sailor's astonishment? Fancy his look of mingled incredulity and wrath? And yet how calmly we look upon these improvements now, taking them as matters of course, and wondering why such things have not always been. In the next century, possibly, "our ancestors," as Paddy said, "will look back upon his posterity" in the same manner in which we look back upon the people of a past age. The wedge being introduced, and the ball of science set rolling, it will doubtless continue to roll, gathering daily every grain of science that the teeming brain of man conceives, and so keep on increasing in volume, and constructing of the diurnal atoms an offering to Him who endows us with reasoning power, until this world itself shall cease to roll its daily course. I have said before that all classes of society on shore *have* their electric telegraphs, and I therefore submit to *this Institution* that it is very hard that sailors should *not* have theirs; and I would also move that this Institution do consider the necessity of applying electricity to certain nautical purposes, believing that should we fit the apparati, sparks will not fly from the wires and set fire to the loose powder about the decks, as some officials to whom the subject was explained have feared, though we can, if we like, by frictional electricity discharge a ship's broadside as one gun.

FLEXIBLE COFFER-DAMS FOR CLEANING AND REPAIRING SHIPS AFLOAT.

By Captain H. F. M'Killop, R.N.

The very limited dock accommodation available for our large ships, either at home or abroad, has now become a serious consideration, both to the Government and mercantile naval authorities. The almost universal use of iron for ship-building, is only checked by the frequent necessity now existing for docking iron ships, to remove the incrustations, weed, &c., which so rapidly form on their bottoms; not large ships only feel this want of dock accommodation, "for in many parts of the world where our ships of war are frequently stationed for three or four years, and to which numbers of our merchant ships are constantly trading," no docks or other convenience for cleansing, painting, or repairing the bottoms of our ships, exist *at all*. Heaving down the long flat-floored ships of the present day would be a long and dangerous process, and in the case of a steamer almost impossible without removing her machinery. The helmet and diving dress, although most useful for examining the bottoms of ships afloat, and even for effecting trifling repairs, does not at all meet the necessity. Coffer-dams have for many years been used for these purposes, but hitherto they have invariably been constructed of rigid material made

expressly, and after the accident had happened, *to fit any one particular part* of the hull, where repair was needed. This was the case with the "Great Eastern," after her accident off New York.

The great expense and delay necessary to fit such coffer-dams renders their use of rare occurrence, and I have only alluded to them, as the machine to which I wish to call your attention bears an affinity to them; but instead of being constructed of rigid material to fit one particular section of the ship, it is made of a flexible material, and capable of being applied to any part of the ship for which it may be made. I claim for this machine the advantage of being inexpensive and portable; when rolled up, not occupying more space than a rain awning or a topsail; the circular backed ladder which goes down inside the coffer-dam, takes to pieces and stows away in a case "*not so large* as a *midshipman's chest.*" The air pump (where one is needed) is quite a small affair. I say where one is needed, because all ships having Gossege's or Hearl's pumps, such as are used in Her Majesty's service, need not have the air pump, as those pumps answer the purpose of inflating the cylinders or tubes by simply taking off the suction and drying the pump well out before using it. My triangular coffer-dam is simply a modification of the other, made to be used at the bow and stern, supported in one case by the bowsprit, and in the other by a spar placed there for the purpose. These machines, although not so portable as the *jacket*, are very important, inasmuch as they enable you to examine and repair your stem and stern post, or in screw steamers with non-lifting screws to do the same to them. As to the question of light to enable the men to see under the bottom, simply a globe-lamp or police light lowered down inside the ladder, answers all purposes, and is only required under the floor.

I now come to the cleaning process without using a coffer-dam; for iron ships up to the present time this has been a great necessity, for although numerous inventions have been announced (my own amongst others) *no one* has yet succeeded in producing a *composition*, the use of which would enable an iron ship to be kept three years on a station where she could not be docked; in fact it is very rare to find an iron ship kept perfectly clean even for a year.

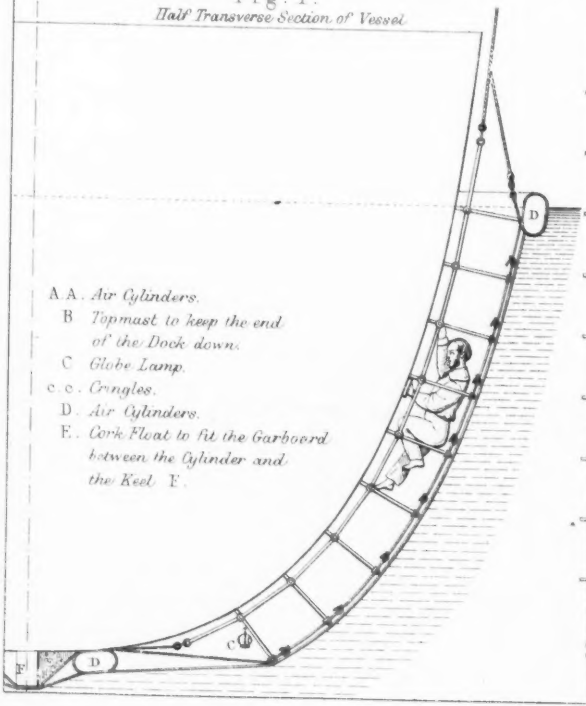
Failing the means of *keeping* ships clean, it becomes necessary to have the means of cleaning them when they become foul. One side of the flexible machine I propose to use, as I have already done, for the purpose of quickly and thoroughly cleaning the bottom of a ship, not by the process of scrubbing or scraping. but by the use of unslaked lime introduced between the ship and the canvas lining, which lime being slightly wetted, soon in the process of slaking, destroys all animal and vegetable life, which may then be readily and thoroughly removed, by the machine being drawn along the bottom, some of the air having previously been allowed to escape from the cylinder, in order to ease the pressure of the machine from the ship's bottom.

In the machine made for the "Recruit" I have brushes introduced near to the cylinders on the off side, simply to remove the lime and any foul matter on which it has already acted. I do not believe in scrubbing iron ships. I have been told by many who have scrubbed their ships,

MACKILLOP'S SYSTEM OF CLEANING SHIPS BOTTOMS.

Fig. 1.

Half Transverse Section of Vessel.



A A. *Air Cylinders.*
B *Topmast to keep the end of the Dock down.*
C *Globe Lamp.*
c c. *Cringles.*
D. *Air Cylinders.*
E. *Cork Float to fit the Garboard between the Cylinder and the Keel.* F.

Fig. 2.

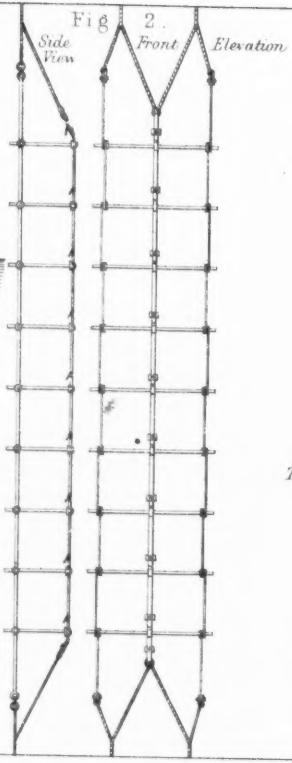


Fig. 3.

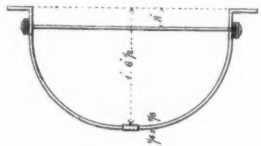
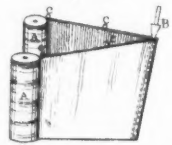
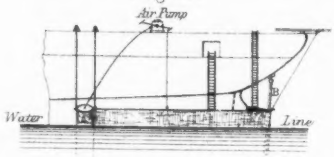


Fig. 4.



Triangular Dock or Coffer dam for Bow or Stern.

Fig. 5.



H.F.M. Mc.K.

J.R. Jobbins

particularly in tropical climates, that after one scrubbing, the growth is three times as quick and is much thicker than it was before. Indeed, I believe that the hogging process at sea only tends to irritate the grass, much as our brushing and sweeping our lawns on shore tends to stimulate the growth of the grass. Whether it is the same with the fish I do not know. The foul matter removed from the "Recruit" in my first attempt at acting upon it by lime, clearly proved that both animal and vegetable life were thoroughly destroyed by the action of the lime, and that life had to be renewed by a new formation. I do not say that in a short time a new formation would not exist, but by destroying it with lime you have this advantage over scrubbing, that you destroy the germ of the animalcule and the seed of the grass.

The evident utility of this machine for stopping a leak needs no comment, the simplicity of its application and the closeness of its fit to the hull, are easily seen. Another purpose for which it may be used is for a *float* or pontoon; by doubling the machine and lacing the parts together, a sort of boat is formed, so buoyant that for landing on a lee-shore through a surf, few boats, built expressly for the purpose, would answer better. In conclusion, I beg to point out, that I do not confine myself to one or two materials for the construction of the air tubes or lining of these machines—in some cases I would use india-rubber, or rather canvas prepared with india-rubber; and in other cases leather riveted as in our hoses; and I propose to try vulcanized rubber, with canvas coverings faced with fearnaught, and luted with beeswax and tallow, on the part of the cylinder which comes in contact with the ship's side and bottom.

In the meantime I have confined myself to leather and india-rubber, and have succeeded, as far as the principle is concerned. The thing is still in its infancy; I trust it may be further developed as a useful means of getting under water to examine ships without the use of diving dresses, and without the great expense of sending ships home from foreign stations to be docked.

I must apologise for the roughness of my models, but the half-pay of a sailor who has to develope the merits of an invention admits of no extravagance in that direction.

The flexible-jointed ladder shown in Figs 2 and 3, is used as a means of going down the ship's side, inside the canvas machine. Fig. 3 shows the arched back piece which prevents the man from being jammed up against the ship's side by the pressure of the water outside, and also gives him room to use a scraper, brush, or other tool, after the water has been pumped out of the coffer-dam thus formed.

Fig. 4 shows triangular dock or coffer-dam for bow or stern. Fig. 5 the same applied to the stern. This figure shows the stern higher out of the water than would be the case under ordinary circumstances.

LECTURE.

Friday, March 18th, 1864.

LIEUTENANT-COLONEL T. ST. LEGER ALCOCK, Vice-Chairman of Council, in the Chair.

THE ART OF COMMAND CONSIDERED WITH REFERENCE TO THE DUTIES OF REGIMENTAL OFFICERS.*

By Lieutenant-Colonel A. CUNNINGHAM ROBERTSON, 8th, The King's Regiment.

COMMAND is the peculiar and characteristic function of every individual holding military rank above that of a private soldier. The greater or less capacity for the exercise of this function measures the fitness of the non-commissioned as well as of the commissioned officer for the rank he actually occupies. It determines the expediency of promoting him to a higher rank.

The authority of the corporal is derived from the same source as that of the colonel. It invests both with the same right to exact absolute obedience; it imposes on both the same obligation to use the power confided to them conscientiously, discreetly, and with a sympathetic consideration for the feelings of those placed under them; it is given to both as a trust to be exercised for promoting the same ends, viz., the good of the service, the maintenance of discipline, the

* In preparing this lecture I have borrowed several illustrations from Colonel Rolt's work on Moral Command, the only book in the English language with which I am acquainted which treats of the subject of the lecture. This work is rather desultory and unsatisfactory in its arrangement, but it contains very interesting statements of the results obtained by the writer by carrying out, when in command of a regiment, the system he recommends.

I have also embodied in my lecture certain views regarding the mode in which authority should be exercised, derived from writers on the government of schools and families, to whose works reference will be made at those parts of the lecture which are borrowed from them.

The idea of this lecture was first suggested to me by hearing an admirable discourse on obedience, delivered by one of these writers, the Rev. Dr. Robert Lee, Professor of Biblical Criticism in the University of Edinburgh.—A. C. R.

preservation of good order, and the exact performance of the appointed duties of their respective offices. Moreover, if any one invested with military authority exercises that authority oppressively, vexatiously, indiscreetly, or unkindly; if a command be given which is harsh, selfish, or unjust; which is useless, or frivolous, or contrary to custom; which is impracticable, inconsistent with other orders, or ill suited to the circumstances of the case; or which, though legitimate and proper, is enforced in an impatient, ill-tempered, or violent way, without sympathy or consideration for the feelings, the weaknesses, and the prejudices, of those who have to obey it, he who gives such a command, whatever may be his grade, whether he be a colonel or a corporal, abuses the authority with which he is invested, and fails in the performance of that function which is the essential characteristic of his rank.

Since, then, the authority of officers and non-commissioned officers of every grade is the same in kind, since it is derived from the same source, has the same claim to obedience, imposes the same duties, is given for the same ends, and is liable to the same abuses, is it not the bounden duty, not only of every officer, but of every non-commisioned officer, anxiously to consider what are the exact limits of his authority? What are the qualifications required for its efficient exercise? What are the general principles, and what the specific rules by which he must endeavour to regulate his conduct in dealing with those under his command?

Obedience is the co-relative term of command. It is the result which he who gives the command desires to obtain. Now, whether a command be obeyed or disobeyed, depends on the respect which is left for the authority of him who issues the order. The art of command may therefore be defined to be "*the art of using those means which are most suitable for ensuring respect being paid to authority.*"

He who exercises authority may rely on three different classes of motives. He may rely on motives which appeal to the hopes and fears, or on those which appeal to the reason and conscience, or on those which appeal to the affections of those under his command. Of these three classes of motives, those which appeal to the hopes and fears are doubtless the most energetic in their action, and the most easily applied. In time of peace, when soldiers are confined within the four walls of a barrack-square, it is, no doubt, possible for an officer, who possesses neither the confidence nor the love of the soldiers under his command, to maintain discipline merely by the use of those powers which the law places at his disposal for compelling obedience, and for punishing those who attempt to resist his authority, or who neglect to obey his commands. But in the field, where the opportunities and temptations to transgress rules are multiplied, where the means of restraint are diminished, and where the service required from the soldier is not merely the exact performance of certain prescribed exercises, but the exertion of every power he possesses—nay, even the devotion of his life at the command of his officer—it is obvious that a system of terror must utterly break down, and that no officer will prove an efficient commander who does not possess the qualities which attract

love and inspire confidence; who is not skilful in the use of those means which enable an officer to exercise a powerful personal influence over the opinions and affections of soldiers.

If, therefore, an officer desire to exercise the authority committed to him in the only way calculated to secure the ends for which that authority is given, he must fix his attention, not on the conditions under which authority is exercised in the barrack-square, but on the conditions under which it is exercised in the field. If he does this he can scarcely fail to see that obedience (however exact and perfectly rendered), if it be merely the result of the vigorous use of severe compulsory means, originates in an inadequate and defective motive. He can scarcely fail to see that the obedience of soldiers to be of real military value, must be not only exact and absolute, but that it must also be willingly and cheerfully rendered. That the spring from which it derives its origin and persistent force must not be the slavish feeling of fear, but the noble feeling of implicit confidence and of sincere personal attachment. He can scarcely fail to see that in order to exercise his authority effectively, he must not trust solely or even principally to the use of force, but must chiefly rely on that moral influence which can only be acquired by the exercise of firmness, the manifestation of wisdom, and by the practice of kindness.

The general principle from which all rules for the successful exercise of the art of command are derived, may be stated in a single sentence:—*Make obedience as easy and as agreeable, disobedience as difficult and as disagreeable as possible.*

The application of this principle is quite independent of the organization of the body to be governed, or of the particular objects or purposes for which the authority of the governing power is exercised. The same mode of exercising authority which is suitable for the command of a regiment, is suitable for the government of a family, of a school, of a ship, of a fleet, of an army, of any organized body, which is required to obey the orders, and to act under the directions of a single chief.

The rules which must be observed, and the conditions which must be fulfilled by the commanding officer of a regiment, are precisely the same as those which must be observed and fulfilled by his subordinate officers and non-commissioned officers, by the captain in the management of his company, by the sergeant or corporal in maintaining order in his room. The corporal is under precisely the same obligations as the colonel, so to exercise his authority as to secure the willing and cheerful obedience of those under his command. The obligation of, both is the same, the result aimed at is the same, and that result can only be obtained by the one, through the use of the same means as must be employed by the other. Whatever be the amount of authority entrusted to him who commands, and whatever be the nature of the service he is appointed to exact—that obedience which originates in feelings of respect, confidence, and love, will only be yielded to him whose authority is exercised with firmness, with discretion, and with kindness. He, therefore, who desires so to exercise

his authority as to make obedience easy, and to inspire those under him with feelings of respect, confidence, and love, must take care that his commands are as few as possible; that they are reasonable, just, and necessary; that they are uniform and consistent; that they are proportioned to the strength of those who have to obey them, and that they are strictly enforced. Regulations or orders which want any of these attributes, must, to the same extent, fail to secure the willing and cheerful obedience of its soldiers. On the other hand, by indulging in the caprices of a selfish or arbitrary disposition, by inconsistency in his orders and requirements, by demanding in the heat of temper what is felt by himself in cooler moments to be harsh, impracticable, useless, or unreasonable, and what therefore cannot be strictly enforced—by these and such like faults an officer will excite feelings of hatred and contempt, which even if they do not break forth in open acts of insubordination and defiance, are nevertheless quite incompatible with the efficient and salutary exercise of military authority.*

The following rules exhibit a statement in detail of the principal considerations which an officer ought to keep continually in view in the exercise of his authority, and by reference to which he ought to accustom himself to test the propriety and expediency of every order he issues. These rules are:—

I.—Take care that compliance with orders shall always be attended with advantage, and that disobedience and neglect shall be invariably punished.

II.—Before issuing an order, consider well what means are available for ascertaining that it is strictly complied with, and make careful arrangements for the supervision of its execution.

III.—Issue as few orders and impose as few restraints as possible.

IV.—Take care that every order issued is legal, just, and useful.

V.—Take pains to render the reasonableness and utility of every order that is issued, manifest to those who have to obey it.

VI.—Take care that every order is expressed in concise, simple language, free from ambiguity, and so framed as to be distinct, and easily understood. When an order is given verbally, the tone of the voice should be decided and free from hesitation.

VII.—In giving directions concerning the method of carrying out an order, take care not to impose any unnecessary labour.

VIII.—Before issuing an order, take care that all necessary arrangements are made for facilitating its execution.

IX.—In issuing a new order, take care that it does not contradict or in any way impede the execution of any former uncancelled order.

X.—When, by a change of circumstances, an order becomes superfluous or mischievous, do not permit it gradually to fall into disuse, but let it be explicitly cancelled. The same rule applies when a mistake has been made, and an order issued, which is found to be improper or inexpedient.

XI.—So manage as never to have the laugh against you.

* Vide "The Family and its Duties," by the Rev. Dr. R. Lee, p. 32.

XII.—In framing regulations and orders, endeavour to adapt them to the convenience of those by whom they are to be obeyed.

I shall now endeavour briefly to illustrate the bearing of these rules on the details of regimental management.

Rule I.

Take care that compliance with orders shall always be attended with advantage, and that disobedience and neglect shall be invariably punished.

Although the power of conferring rewards and of inflicting punishments must always be the foundation on which authority rests, yet the chief aim of every one invested with authority should be, to secure obedience without exercising this power. An officer should accustom himself to consider the necessity of ordering punishment, as a proof of failure, he should regard the amount of success that attends his efforts to maintain discipline, without the infliction of penalties, as the measure of the degree of skill he has attained in the art of command.

The most effectual means of diminishing the frequency of punishment, is to make its infliction certain. A very slight penalty (provided there be no chance whatever of escaping its infliction) will operate more effectually in deterring soldiers from the commission of crime, than the liability to a penalty of the most extreme severity, but the infliction of which is rendered uncertain, either by facilities for concealing guilt, or by the too frequent or the capricious exercise of the power of remission.

The efficacy of punishment is therefore not in proportion to its severity, but in proportion to the certainty of its infliction. Indeed, great severity is not only unnecessary, it is positively injurious. It has a tendency to tempt non-commissioned officers and witnesses to screen offenders, and to conceal crime.

If it happens that the officer who has to administer a rigorous system, thinks it too severe, he is apt to construe facts and evidence, with an undue bias, in favour of the prisoner, and also to make arbitrary exceptions and remissions, the effect of which is, to diminish the certainty of crime meeting a fitting retribution, and therefore to increase the temptation to commit offences.

That system of punishment is most likely to be efficacious, which imposes penalties of moderate severity, so graduated as to discriminate between men who seldom commit offences, and whose general character is good, and men of bad character, who are habitual offenders; which defines with precision the cases in which these penalties will be inflicted, and which is so efficiently, impartially, and consistently administered, that few offences are committed which are not detected, and that no offence is detected which is not visited by the prescribed penalty.

The effect of previous good conduct in averting or diminishing punishment, should be regulated by general rules; all cases which are similar in their character should be punished by the same penalties. I select three cases of the offences most frequently committed by soldiers, to illustrate the manner in which rules may be framed for

awarding punishment in a systematic way, according to a graduated scale.

Ist Crime.—Late turning out for parade or roll-call.

Punishments.—If 6 months clear on the defaulters' book, reprimand by the captain.

2nd offence within 6 months, 3 days confined to barracks (to be awarded by captain without confining soldiers).

3rd offence within 6 months, 7 days confined to barracks.

4th offence within 6 months, 10 days confined to barracks,

IInd Crime.—Absence from tattoo, not exceeding 24 hours.

Punishment.—If 12 months clear of defaulters' book, reprimand.

If 6 months clear on defaulters' book, 7 days' confinement to barracks.

2nd offence within 6 months, 10 days' confinement to barracks.

3rd offence within 6 months, stoppage of pay, and 14 days' confinement to barracks.

4th offence within 6 months, stoppage of pay, and 21 days' confinement to barracks.

5th offence within 6 months, stoppage of pay, and 28 days' confinement to barracks.

6th offence, stoppage of pay, 168 hours' imprisonment, 14 days' confinement to barracks.

7th offence, regimental court-martial.

IIIrd Crime. Drunkenness.—If 12 months clear of defaulters' book, reprimand.

2nd offence within 12 months, 7 days' confinement to barracks.

3rd offence within 12 months, 14 days' confinement to barracks.

4th offence within 12 months, 28 days' confinement to barracks; or if within 3 months of previous instance, 168 hours' imprisonment, and 14 days' confinement to barracks.

5th offence within 12 months, regimental court-martial for habitual drunkenness.

The establishment of a graduated scale of punishments for minor offences is most useful in preventing officers in command of detachments from dealing with defaulters more or less leniently than they are dealt with at head-quarters; but its principal utility consists in keeping the manner of dealing with crime at head-quarters uniform; and preventing any inconsistency between punishments awarded by the Lieutenant-Colonel and those awarded by officers in temporary command. Indeed, unless some scheme of awarding punishment be deliberately formed and adhered to, it will be found even when no change occurs in the commanding officer, that the manner of dealing with offences will not be uniform, and that a commanding officer is very liable to incur the imputation of partiality by awarding to precisely similar offences, committed at different times, very dissimilar penalties.

It is much more difficult to deal with the offences of non-commissioned officers, according to a uniform scale, than with those of privates.

There are many irregularities and neglects for which reduction

appears too severe a punishment, and yet which either in their own nature, or on account of having been more than once repeated, are too serious to be adequately dealt with by a mere reprimand. In cases of this kind, a commanding officer frequently feels it very difficult to decide how to act, and is apt occasionally to come to opposite conclusions regarding offences precisely similar in their character.

To enable a commanding officer to deal satisfactorily and consistently with the offences of non-commissioned officers, I think power should be given to him to impose fines, and award stoppage of part of their pay for a limited period. I think also, that in dealing with sergeants convicted of such offences as neglect of duty, or of conniving at, or failing to report irregularities, a discretion should be allowed to courts-martial of reducing them to the rank of corporal instead of to the rank of private.

The chief power of reward vested in a commanding officer is that of selecting men for promotion, but by making the granting of passes, furloughs, and other indulgences, dependent on good conduct, and by exempting well-conducted men from some of the ordinary parades and roll-calls, the efficacy of this means of government may be very considerably increased.

The attainment of certain desirable objects, such as attendance at school, which it may not be expedient to enjoin imperatively, or to enforce by the infliction of penalties, may also be effected by the judicious employment of suitable inducements, such as exemption from some parades and from all fatigues.

Rule II.

Before issuing an order, consider well what means are available for ascertaining that it is strictly complied with, and make careful arrangements for the supervision of its execution.

The practical difficulty in the art of command, does not consist so much in determining what orders are proper to be issued, as in keeping up a system of efficient superintendence, and in the energetic exercise of personal vigilance, so as to make sure that whatever order is given, shall be strictly complied with.

To organize such a sytem of superintendence as shall ensure exact compliance with whatever orders may be issued, is of more importance than to determine in each particular case what orders are most expedient and most fitted to attain the end in view. Whether a particular order be useful or superfluous, judicious or injudicious, expedient or inexpedient, may sometimes be a matter of very small importance—almost of indifference. The mischief done by an improper order, depends on the greater or less importance of the matter to which the order relates. If the matter be trifling, the mischief done by the improper order will also be trifling. But the mischief done by permitting an order to be neglected or disobeyed, in no degree depends on the subject to which the order relates, in any quality of the order itself. Whether an order be right or wrong, expedient or inex-

pedient, important or trifling, the injury done to discipline by neglecting to enforce exact compliance with what is prescribed, is the same. Whether, for instance, soldiers sit down to dinner with their jackets buttoned or unbuttoned, is a matter of no great importance, and, therefore, it cannot matter much what order a commanding officer thinks proper to give about the dinner dress. But if he decide that the jackets shall be buttoned, and gives an order to that effect, then it becomes a very important matter that the rule laid down should be strictly adhered to, and if he suffer the order he has given respecting this trifling matter to be neglected, he suffers a very serious injury to be done to the discipline of his regiment.

The difference between a regiment which is well commanded, and one which is ill commanded, will be generally found to consist less in the nature of the orders issued, than in the manner in which they are enforced. No orders, however excellent, will produce satisfactory results, unless enforced by a good system of supervision, but no system of supervision, however skilfully framed and perfect in theory, will work well unless directed and controlled by a vigilant and energetic chief.

In the command of a regiment, the same rule holds good as in the general conduct of human affairs—men come first, measures afterwards. An energetic commanding officer working with a bad system, is to be preferred to a good system carried on by a feeble, irresolute chief.

The practicability of enforcing obedience, is then a matter which must be always carefully considered before issuing an order. If in any particular case it be foreseen that this essential condition cannot be secured, an officer, instead of attempting to obtain the desired result by means of a direct order, should rather endeavour to accomplish what is wished to be done, in some other way.

Rule III.

Issue as few orders, and impose as few restraints as possible.

The problem to be resolved in the government of soldiers is the same which presents itself in all possible governments. "The "thing to be done is always the same: to reconcile the greatest "possible amount of individual liberty, with the most perfect submission "to law."* Zealous and energetic commanding officers sometimes act as if this statement of the conditions of the problem were erroneous, as if the true object to be aimed at were, not to increase the amount of liberty allowed to the soldier, but to restrict it within the narrowest possible limits. As if the amount of liberty he actually possesses were a proof of failure, a thing to be regretted, an imperfection to be remedied.

Numerous minute regulations harass and irritate the soldier. He is also harassed, if the work of instruction, or the work of superintendence, or both, be overdone by parades of unnecessary length, or by inspections of unnecessary frequency.

* L'Education Progressive, par Madame Necker de Saussure.—Liv. 1, chap. v.

If the constant meddling of a commanding officer with matters where his interference is not required, be harassing to the soldier, still more mischievous and intolerable is the meddling of an over zealous non-commissioned officer. Although prevention is better than cure, yet it is certainly better for a non-commissioned officer to permit men to run the risk of being occasionally punished for neglect, than to be continually reiterating orders and tormenting men by directions and inquiries concerning their execution. Admonitions and exhortations, to be effective, must be seldom employed: nothing is more irritating, and more certain to create feelings of dislike and contempt, than habits of constant interference and fault-finding.

That system of management which, with the view of diminishing temptation to crime, is opposed to granting passes and indulgences, appears to me contrary to the principle of this rule. Let all possible means be taken to induce men to avoid and to resist temptations. Endeavour to foster tastes for innocent recreations, and to create facilities for the indulgence of such tastes; punish every instance of depravity or vicious indulgence, but do not treat soldiers like children or convicts. Do not attempt to render crimes impossible by the extinction of liberty.

The standing orders of a regiment should be few in number, they should be perfectly clear and concise, not liable to frequent exceptions, nor limited in their application to particular times and circumstances. The principal matters which ought to be defined in the standing orders are—

1st. The routine of daily and weekly duties, specifying the respective duties of the captain and subaltern of the day.

2nd. The daily and annual routine of parades and exercises.

3rd. The manner and periodical times of auditing the company, mess, band, and quartermaster's accounts.

4th. The inspection of necessaries, arms, and accoutrements.

5th. The conditions of granting passes, furloughs, and indulgences.

6th. The rules to be observed in inflicting minor punishments, including the definition of the classes of offences to be dealt with by captains of companies.

8th. Regulations for the selecting and promoting non-commissioned officers, specifying the conditions of conduct and service, and educational qualifications required for each rank.

In determining the number and duration of parades, the number of passes to be granted to each company, and generally in deciding upon any matter which either affects the amount of work to be exacted from soldiers, or the degree of restraint to be imposed upon them, a commanding officer ought not to be guided merely by his own notions of what is reasonable and proper. He ought neither to exact more work, nor to impose more severe restraints than is sanctioned by the general practice of the service.

A commanding officer is under no obligation, nay, he is invested with no authority to enforce conformity to the rules of morality further than is required for the maintenance of military discipline. I remember hearing of a non-commissioned officer being placed under arrest

for having been seen talking with a prostitute in the bazaar of an Indian cantonment. It appears to me that in this case the exercise of the power of arrest, if not absolutely illegal, was undoubtedly very injudicious. If the right, or at all events the expediency of using military authority to enforce the observance of moral rules be limited to cases in which their violation is clearly prejudicial to discipline, we see a reason why certain irregularities may be tolerated in the quarters of an officer, which it would be necessary to punish most severely if committed in a soldier's barrack-room.

The obligation to abstain from using military authority to promote any other ends, however excellent, than those specific ends for which it is given, is perfectly consistent with the still higher obligation imposed upon officers as upon all other men, both by their example, and by exerting their personal influence upon those with whom they are connected, to do all in their power to promote virtue, and to discourage every species of immorality. A commanding officer is bound so to speak and act that his toleration of certain infringements of morality shall not be construed to signify sanction and approval.

Rule IV.

Take care that every order that is given is legal, just, and useful.

The motives which tempt officers to issue orders of questionable legality are frequently laudable. One of these motives, viz., zeal for the interests of morality, has just been discussed. Another somewhat analogous motive is a desire to excel, the ambition to command soldiers distinguished by the smartness of their appearance. Orders to soldiers to provide themselves with any article not required by regulation, or with necessaries of superior quality, such as smart forage caps or padded jackets, are instances of the violation of the rule proceeding from this motive. So also are the inconsiderate and very oppressive orders sometimes given by captains, that new articles of clothing shall be provided before the old ones are worn out.

If soldiers are attached to their officers and animated by a strong *esprit de corps*, they may be easily induced to acquiesce in any moderate extra charge thought necessary to keep up the credit of the corps, and to increase its reputation for smartness of appearance. But however strong the general feeling may be in favour of submitting to the charge required by the commanding officer, there will always be a certain number of individual grumblers, anxious to evade the change and dispute the order. To avoid even the slightest risk of compromising his authority, a commanding officer should never on any consideration issue an order, the legality of which is liable to be questioned and disputed even by a single soldier.

Unjust, as distinguished from illegal orders, generally arise from faults of temper; sometimes, but much more rarely, from errors of judgment. It is only in rare and exceptional cases that an officer is misled by misrepresentations, or that he forms an erroneous estimate of evidence, but there are many officers who are habitually

influenced by feelings of favouritism or of aversion; and there are very few who in dealing with individuals are not occasionally biassed by personal likings and dislikings. Even in issuing orders of general application, an officer of an irritable temper may be provoked to order a whole company to attend extra drill on account of the mistakes of the officer who commands it; or, still worse, he may order extra drill on account of mistakes occasioned by the indistinctness of his own word of command. When any penalties or restrictions are imposed upon a whole body of men, such as a company or a regiment, on account of the misconduct of a limited number of individuals, it is essential that the expediency and utility of the order should be clearly manifest, and that not the smallest appearance of passion or want of consideration should be exhibited in the issue of the order. A good means to prevent dissatisfaction with orders of this kind is, whenever practicable, to define before hand the cases in which they will be issued, *e.g.*, to give notice that whenever a man is absent from tattoo, a certain number of files of the company he belongs to shall be sent out to look for him; or that when the number of defaulters in a company exceeds a certain number, the passes of that company shall be stopped.

Useless orders are of two kinds, those which prescribe unsuitable means for the accomplishment of a useful end, and those in which, though the means prescribed are well adapted to accomplish what is required to be done, the object sought to be accomplished is itself useless or improper.

No officer ever issues an order which he himself perceives at the time is not suitable to the circumstances of the case, but when an order has been once issued, it is frequently obstinately enforced, although experience has proved, and he who gave the order very well sees, that it is useless or injurious. There can be no doubt that the admission of failure implied by cancelling an abortive order has a tendency to diminish the confidence felt in the judgment of a commanding officer, and to weaken the respect felt for his authority; but to persist in an error does not conceal it, and to enforce the doing of that which is manifestly useless or mischievous, creates feelings of irritation and dissatisfaction far more prejudicial to the authority of a commanding officer than the mere diminution of confidence produced by the perception of error or failure.

Before issuing an order an officer should consider well how it will work. He should consult those best qualified to give him reliable information or sound advice. He should seek to ascertain whether what he considers advisable is considered advisable by others also, who look at what he proposes from a different point of view. In special cases this precaution is seldom neglected. Few officers would think of issuing sanitary regulations without consulting the doctor. It seems to me that it would be wise, even in the most ordinary cases, and as a general rule, to issue no order whatever without consulting those by whom it is to be obeyed. Officers should, I think, be consulted about mess regulations; captains of companies about transfers, promotions, punishments, and indulgencies; pay-ser-

geants about matters of account; the adjutant and drill instructors about parades and exercises; and private soldiers about the fitting of their accoutrements, the packing of their knapsacks, the material and fashion of their clothing, and the arrangement of their barrack-rooms.

Officers of an arbitrary disposition are apt to feel irritated and impatient when any difficulties or obstacles are stated, which it is foreseen will impede the execution of the orders which they propose to issue. Such officers seem to imagine that to listen to objections implies weakness and want of confidence in their own judgment. The reverse of this is true; generally speaking those officers who are most willing to listen to the opinions of others, and most disposed to seek for advice and information, are those who are most conscious of possessing the power of dealing with difficult questions, of estimating the worth of conflicting opinions, of answering objections, and of discovering expedients to remove obstacles and to overcome difficulties. Those officers, on the contrary, who make a mystery about everything, who carefully conceal their intentions, who avoid discussions, and who resent the statement of difficulties, though they may be energetic and possessed of a strong will, are, generally speaking, men of inferior intellect, men who are only able to look at a subject from a single point of view, who are perplexed, not enlightened, by the statement of conflicting opinions, who, because they possess few resources for obviating difficulties, are puzzled and provoked when difficulties are brought to their notice.

When any doubt exists as to the manner in which an order will work, it should be first issued as a tentative measure for a limited period, at the end of which reports should be called for.

As an instance of the use of unsuitable means to promote a necessary end, may be mentioned the practice, lately prohibited, of frequently washing floors and passages as a means of keeping them clean.

The other class of useless orders are those in which the means prescribed are appropriate, but the end proposed is useless, that is, does not conduce to any necessary military object. An exaggerated love of method and uniformity is perhaps the most prolific source of superfluous and mistaken orders. How many vexatious, utterly useless regulations have originated in perverted notions regarding what is necessary to give a soldier a smart military air. Without adverting to the powder and pigtails of the days of our grandfathers, when it is said that in order to pass muster at a full-dress morning parade it was necessary for a soldier to begin dressing the night before, we know that, only the other day, the Commander-in-Chief found it necessary to caution officers against insisting on great coats being folded in such a way as to injure the cloth and to cause the soldiers much useless trouble and inconvenience.

Uniformity ought not to be regarded as a thing which is valuable in itself, and desirable for its own sake, but as a thing, the value of which is to be determined by reference to something else to which it stands in the relation of means to an end. Officers should not restrict their thoughts to the consideration of such questions as these: By what means may absolute uniformity of dress and equipment be attained? By what means may soldiers be trained to absolute uniformity in their

movements and exercises? How may the sphere of individual action be most effectually limited so that a regiment may be made as like a machine as possible? They should accustom themselves to go a little deeper into the matter, and to ask themselves wherein consists the utility of absolute uniformity in dress and equipment? In what way does uniformity of movement contribute to efficiency in the field? To what extent is it essential? To what extent is it practicable? Would the complete obliteration of all individual action be beneficial? What are the conditions under which many individual wills most effectually co-operate towards the attainment of the various objects of military organization?

When thus considered in relation to the objects which it is adapted to promote, it will easily be perceived that absolute uniformity is by no means the highest conceivable ideal of military organization. That absolute uniformity of dress, though advantageous in an economical point of view, is at variance with the principles of beauty, and quite destructive of picturesque effect. That absolute uniformity of movement is not only impracticable, but if practicable, would be useless for the purposes of war. That the attempt to obliterate all traces of individual action, and to treat soldiers merely as parts of a machine, is a clumsy expedient for producing a very partial and limited effect by an enormous expenditure of power.

Rule V.

Take pains to render the reasonableness and utility of every order that is issued manifest to those who have to obey it.

The essential characteristic of an officer's authority is, that it is ministerial, not autocratic. That it is the expression of law, not of the personal will of him who exercises it.* The soldiers he commands are his followers, not his servants. He is the guide who points out the path, but he does not choose its direction. The orders he gives are declaratory, not of his own will, but of a superior will, not of might, but of right. He claims obedience, not merely because he has the power to enforce it, but because what he requires is right, and according to law. So to exercise command that his authority shall exhibit this aspect to those subordinate to him, ought to be the constant aim of an officer. Both by the nature of the orders he gives, and by his manner of giving them, he should endeavour to make those under him feel the difference between law and personal desire, between the authority of a leader, and the arbitrary will of a master. He should neither act, nor should he seem to act, as if his own will were the law, and as if the orders he gives might be enforced or cancelled, as best suited his own convenience. He should not appear to be capriciously absolute, when, in fact, he is merely exercising a delegated authority, and enforcing a law which he himself is as much bound to observe as those under his command. If it be the duty of a commanding officer to require all

* Vide the Principles and Practice of Common School Education, by Rev. J. Currie.

under him to be punctual in the observance of stated times, and exact in the performance of appointed duties, it is no less imperative that he should himself set an example of punctuality and exactness.

Of course, great discretion must be exercised in the manner of fulfilling the obligations of this rule. An officer must take great care, lest in endeavouring to make the reasonableness of an order apparent to those who are to obey it, he should do or say anything which might be so construed as to be inconsistent with the obligation of absolute, unquestioning, unhesitating, obedience; which might be imagined to imply, that the duty of obedience is in any way dependent on the estimate which a soldier may form of the reasonableness of the order given him by his commanding officer. But this very necessity of exacting from soldiers absolute obedience, is the strongest reason that can be adduced for an officer endeavouring so to exercise command, that in those cases where the motive of an order is not perceived or is misunderstood, a general feeling of confidence may supply the place of a direct perception of the propriety and utility of the particular thing that is required to be done. That, however repugnant an order may be to the feelings of soldiers, however contrary to their ideas of what is right, they shall nevertheless feel perfectly satisfied that no order is ever given which originates in blind caprice or mere arbitrary will.

If an order be really useful, although its utility may not be obvious at the time it is issued, the manner in which it operates generally soon shows it to be beneficial. It is only in very exceptional cases that the value of a useful order cannot be easily perceived without explanations, and in these cases it is seldom expedient to resort to formal explanations, as a means of rendering apparent the utility of the order. To invite men to canvas an explanation, has a very different tendency from taking pains to render the connection between an order and its result obvious to their perceptions. Nevertheless there are cases when, if it be foreseen that the intention of an order is likely to be misunderstood or misrepresented, it may be expedient authoritatively to declare its motives, and to point out the end it is intended to effect.

Rule VI.

Take care that every order is expressed in concise, simple language, free from ambiguity, and so framed as to be distinct and easily understood. When an order is given verbally, the tone of the voice should be decided, and free from hesitation.

This rule expresses one of the necessary conditions which must be complied with, in order to fulfil the obligation expressed in the preceding rule. That the utility of an order may be perceived, it is evident that it must be so framed as to be easily and perfectly understood. Moreover, to inspire confidence and command unhesitating obedience, an order must be given with confidence and decision. If an officer, by a hesitating, undecided manner, shows that he himself is doubtful about the utility of his own order, and hardly knows whether it is right or wrong, it is evident that, though the order may be really perfectly right and suitable, it will fail to inspire confidence, it will

be obeyed with hesitation and reluctance, and most probably not without remonstrance and applications for explanations and directions. Presence of mind, and clearness of perception, are the qualifications on which decision and distinctness of expression depend. It is impossible for a muddle-headed nervous man to give a clear, decided order.

In manœuvring troops, clearness of tone, and proper modulation of the words of command, is a very important matter, and ought to be made the subject of persevering and systematic instruction. The voice of every officer should be carefully trained in the manner pointed out in Part I., General Principle V., page 3, of the Field Exercises, and no young officer should be dismissed from drill until the commanding officer is satisfied that he has been thoroughly initiated in the art of managing his voice, and has acquired the habit of giving the word of command in the manner pointed out by regulation. A slovenly or inaccurate pronunciation should never be tolerated on parade, and an error in accent or in the pitch of the voice should be corrected with as much care as a deviation from the words prescribed by regulation.*

Rule VII.

In giving directions respecting the method of carrying out an order, take care not to impose any unnecessary labour.

In cases where there are two or more methods of doing a thing, one easy and convenient, the other complicated and troublesome, it is very injurious to the prestige of a commanding officer and to the confidence felt in his judgment if, through carelessness or defective information, he unluckily selects the wrong method.

Rule VIII.

Before issuing an order, take care that all necessary arrangements are made for facilitating its execution.

To issue an order which cannot be complied with, unless certain preliminary details have been properly arranged, and then to punish or find fault with soldiers for non-compliance or for failures originating in these arrangements having been omitted or mismanaged, is sure to create discontent. The men will feel that the shortcomings for which they are reproached are in reality attributable, not to their neglect, but to the carelessness or incompetence of their commanding officer. Of course it is not meant that the commanding officer is personally to arrange every detail necessary to be attended to, in order to insure the due execution of his orders. But it is his duty to ascertain, both by

* One of the methods of instruction practised at the schools of musketry, termed "Communicating drill," seems to me admirably adapted for affording to officers the kind of practice requisite to acquire a good word of command, and fluency of expression in delivering orders. This exercise ought certainly to be adopted as part of the regular routine of the regimental instruction of officers.—A. C. R.

reports and by personal examination, that the arrangement of such details as he may think proper to leave to his subordinates have not been mismanaged or forgotten.

Rule IX.

In issuing a new order, take care that it does not contradict or in any way impede the execution of any former uncancelled order.

Without considerable care and adherence to method, orders emanating from different authorities, or from the same authority, but promulgated through different channels, are apt to conflict with one another. Of course it is the duty of the subordinate to regulate all matters within the sphere of his own authority, with reference to the orders given by his superior. The colonel must take care not to issue any order which in any way conflicts with those of the brigadier. The captain must conduct all the details of company management with constant reference to regimental orders. Captains ought to be especially careful not to harass their pay-sergeants by requiring their attendance at hours when their time is fully occupied in preparing returns, or in superintending the execution of orders conveyed to them through the adjutant, paymaster, or quartermaster.

But in issuing an order it is not sufficient for an officer to take into consideration orders issued by independent authorities; reference must also be made to the bearing of the proposed order on other orders issued by himself. A commanding officer, for instance, before making any alteration in the hours of parades or of school attendance, must take into consideration the whole routine of regimental arrangements. So also in calling for troublesome returns, he must take into consideration the other duties of those required to furnish them, and should either temporarily dispense with the performance of some of those duties, or else should so calculate the time he allows for the completion of the returns, as to admit of all other duties being duly performed.

The thing to be guarded against is, to require so much, that some of the things required must unavoidably be left undone. Those failures of exact and punctual compliance with orders which arise from the thing required being impracticable, are as injurious to discipline as those failures to comply with practicable orders which, through the negligence or irresolution of the officer who gives the order, are suffered to pass unpunished.

Rule X.

When by a change of circumstances, an order becomes superfluous or mischievous, do not permit it gradually to fall into disuse, but let it be explicitly cancelled. The same rule applies when a mistake has been made, and an order issued which is found to be improper or inexpedient.

Whenever an order can be neglected without inconvenience, this is a proof either that it is superfluous and ought never to have been issued, or else that through a change of circumstances, it has become unnecessary or mischievous, and ought to be cancelled. But however

mischievous or useless an order may be, until cancelled by competent authority, it ought to be scrupulously obeyed.

The obligation to obey an order in no degree depends on the utility of the thing commanded, and the injury done to discipline by neglect or wilful disobedience is the same whether the order disregarded be useful or mischievous. Moreover, whether the reason why a commanding officer suffers an order to be neglected be, that he has entirely forgotten the existence of a useless order, or whether it be, that he has not energy to enforce obedience to a useful order, the injury done to discipline is very nearly the same. The injury consists, not in the utility of the thing neglected, but in the breach of the habit of obedience.

To obviate all risk of orders being disregarded before they are cancelled, or of being acted on after they have become useless, not only all standing orders, but all orders directing anything to be done, or imposing any prohibitions, either for a definite period or until further orders, ought to be extracted from the daily order book and separately recorded. Once a month, or oftener, this record should be carefully looked over, and, if required, any orders in it cancelled or altered so as to suit any change of circumstances that may have occurred since the previous revision.

Rule XI.

So manage as never to have the laugh against you.

This rule is borrowed from Colonel Rolt's work on Moral Command,* and is illustrated by the following incident. Colonel Rolt says :—

"When stationed at Athlone in the year 1823, I, one day on parade, desired the captain of one of the companies to call four men to the front whose hair I had remarked upon the day before. I observed a sort of titter throughout the Company, which broke into a decided laugh when, on being directed to take off their caps, the four fellows presented four bare sculls. Thinking to have the laugh against me, they had cut their hair almost as close as if their heads had been shaved. The attempt to turn an order into ridicule is almost enough to try a commanding officer's amiability, but with a little effort I kept myself cool, for it occurred to me that if I got angry I should have the laugh against me, so instead of showing that I was annoyed I joined in the laugh, which then became both loud and general. After a little I said : 'Well, I am sure you are four good-humoured fellows to have afforded us all so much amusement; but although I am very glad in this way to have a laugh among ourselves, yet I should not like strangers to laugh at us.' I then asked the captain how long he thought it would take before the men's hair would grow sufficiently for them to appear in public. He replied, 'Six weeks.' I then said to the men, 'I should be quite distressed if your sweethearts were to see you in so unbecoming a plight, and, therefore, I am forced to order you to be confined to barracks for six weeks.' The four fellows looked very silly, and I do not think that they ever again tried to turn any order of mine into ridicule."

Rule XII.

In framing regulations and orders, endeavour to adapt them to the convenience of those by whom they are to be obeyed.

* Third edition, W. Clowes. London, 1842.

The first consideration of a commanding officer ought to be the good of the service; the next the well-being and convenience of those under his command. To promote either of these objects, he ought, at all times, to be ready to sacrifice his own personal inclinations and convenience. An officer of an unselfish disposition, who feels a real and lively interest in the well-being of those under his command, will find many opportunities of showing the influence of these feelings in determining the manner in which he exercises his authority. He will fix the hours of parade, the time of transacting orderly-room business, and the whole routine of the daily regimental duties and arrangements, not with reference to his own habits and pursuits, but with reference to the habits and pursuits of those under his command; as a general rule, preferring the convenience of the private soldiers to that of the non-commissioned officers, and the convenience of the non-commissioned officers to that of the commissioned officers. He will never suffer himself to be tempted to impose extra tasks, or to exact extraordinary efforts from his men, merely for the sake of reflecting credit on himself and of obtaining the reputation of being a smart officer, but in determining the kind and amount of work to be required from his men, he will be guided solely by the consideration of what he considers to be necessary for the good of the service, and to be most conducive to the well-being and happiness of the men.

The natural effect of exercising authority in accordance with those principles, will be to inspire feelings of affection and good will. The devotion of his followers is the certain reward of the self-sacrifice of a leader. But it is chiefly in dealing with individual soldiers that an officer of a sympathetic, unselfish nature finds opportunities for displaying those noble qualities and generous sentiments which kindle enthusiasm and attract love. Not only will an officer who really loves his men show the most hearty appreciation of everything that is praiseworthy in the actions or character of those under his command; not only will he do everything in his power to encourage good men, to foster good resolutions and to stimulate to virtuous efforts; he will, if possible, manifest a still deeper solicitude for the welfare of men of bad character; and if among these, there be one man worse than the others, it is for him who has most grievously erred that the deepest solicitude will be felt, for his benefit that the most strenuous efforts will be used.

Colonel Rolt thus describes his manner of dealing with a sergeant who had been sentenced to be reduced to the ranks and to receive 800 lashes for attempting to take the life of his commanding officer. He says:—

"After having watched him and studied his character for some time, I one day called him to my quarters and thus addressed him. 'Your name, I think, is Dudley.' He raised his hand to his cap and answered, 'Yes, sir.' I said, 'I have observed you for some time. Your appearance is much in your favour, you are as clean and well set up a soldier as there is in the regiment. I know your history. It would seem that no one speaks to you, nor do you associate with any one. I am aware of the cause of your being thus shunned. You once contemplated a crime of the most revolting nature—that of murder. You attempted the life of your commanding officer. You were tried, found guilty, and sentenced. All this is true, is it not?'

He touched his cap again, and said, 'Yes, sir!' but not a muscle moved. 'Dudley,' I said, 'your officers have a horror of you, but such a feeling on their part is not to be wondered at.' Still his countenance remained unchanged. 'Now attend to me, Dudley; I have watched you for some time, and I pity you. I should like to give you an opportunity for recovering your place in society, and for regaining that good character which once recommended you to the notice of your superiors. I feel desirous of giving you a trial by making you a corporal, in order that, should your conduct deserve it, I may still further promote you. Will you, Dudley,' said I, looking at him earnestly, 'endeavour to do justice to my good opinion? Do you wish for promotion?'

"The poor fellow could not answer me; his whole frame was convulsed; he cried like a child. I patted him on the back, and said, 'That will do, Dudley, you shall be in orders to-morrow.' He was accordingly promoted, first to be a corporal, and afterwards to be a sergeant, and there was not a better non-commissioned officer in the regiment."

It will very much increase the influence of an officer over the affections of soldiers if he heartily joins in their sports and amusements. This is especially the case when an officer is an adept in those sports to which his men are most devoted, and excels in those qualities of strength and agility upon which pre-eminence in these sports depends. A keen and good cricketer is almost sure to be an influential commanding officer.

The following extract from the work of Colonel Rolt recapitulates much that I have said in illustration of the twelve rules which I have had the honour of submitting for your consideration:—

"The duty of an officer is as much to conciliate as to instruct; to do all in his power to render the lives of those under his command happy, and to attach them to the service. If we disgust, although we may instruct, we do but little in forwarding the cause we have all at heart. Therefore, when practicable, conciliation and instruction should go hand in hand.

"All punishments likely to make men sulk should be avoided. Strict and impartial justice should be the leading attribute of authority. No favouritism, no tittle-tattle, should be allowed to exist, but an undeviating integrity of purpose should ever mark the bearing and deportment of him who holds Her Majesty's Commission. He is entrusted with a high delegated power. How careful should he be that such power be properly administered.

"Coercion must of course be used when coercion is necessary, but no caprice, no teasing, should ever be permitted to weaken moral influence, without which a commanding officer is but half himself. Let him indeed but possess the hearts and affections of his officers and men, and little drill will be required, little punishment will be necessary."

Regarding soldiers, Colonel Rolt says:—

"They should regard their commanding officer with feelings of respect and devoted affection. They should look upon him as their leader, their friend, their protector; they should dread his frown, they should covet his favour. His glory they should consider as their own glory. Any dishonour done to him by irregularity or disobedience, they should consider their own dishonour. In short, the fair fame of their commanding officer should be as dear to them as the fair fame of a parent."

Thus speaks Colonel Rolt. If then an officer desire worthily to fulfil the honourable function of command, let him remember, it is indispensable, that he should assiduously practice the noble virtues of self-sacrifice and of self-control.

The CHAIRMAN: Gentlemen, after the excellent, the interesting, and useful lecture which you have heard, you will desire that the thanks of this meeting be voted to Colonel Robertson for the favour which he has conferred upon us. He has mentioned the authors whom he has consulted on the subject, and I do not find among them the name of the Comte de Saxe,* with whom I trace throughout the lecture a coincidence of opinions, and whilst returning your thanks I shall use, as far as I can recollect them, the words of that great man in saying, that such a system on the part of one in command will increase not only fear and love, but a cheerful and successful obedience.

* I have read the reveries of Marshal Saxe, but it is many years ago. I did not remember that they contained anything immediately applicable to the subject of my lecture, otherwise I should certainly have referred to them with the view of obtaining materials for its preparation. I consider the coincidence pointed out by Colonel Alcock as a strong confirmation of the correctness of the principles submitted for consideration.—A. C. R., Fleetwood, 18th June.

Evening Meeting.

Monday, March 7th, 1864.

CAPTAIN SIR JOHN C. D. HAY, Bart., R.N., M.P., Chairman of Council, in the Chair.

NAMES of MEMBERS who joined the Institution between the 29th February and 7th March, 1864.

ANNUAL.

Boyle, Alexander, Captain R.N. 1*l.*
Hughes, A. C., Lieutenant 2nd Life Guards.
Hore, E. G., Captain R.N. 1*l.*

WOODEN-CASED VERSUS IRON-CASED SHIPS OF WAR.

Contributed by Colonel C. F. PARKINSON, late 70th Regt.

As it is an unsolved problem whether wooden or iron ships, or ships built of wood and covered with armour plates of iron, are the most suitable for ships of war, I trust that I may be pardoned for proposing for discussion—and I humbly hope for trial—another plan of building men-of-war. I propose having iron ships with *external* wooden casing all over them. First to the iron ship; have perpendicular timbers or planking 2 feet square firmly bolted with screw bolts (the heads counter-sunk in the timbers) to the bottom and sides of the iron ship, so close together as to be caulked between each; and with asphalted felt between them and the iron bottom, sides, &c. Over these place horizontal 8-inch planking, secured to the underneath perpendicular or upright planking or timbers by copper bolts of 20 inches long. This double planking crossing at right angles to have Jeffries' marine glue between them, and to be caulked.

The advantages of this plan are, that the copper and iron need not come in contact. No galvanic action to destroy either. By having the *iron inside* the timbers, there would be fewer splinters from that than when timber is a backing or lining to the iron sides. And by placing an iron ship thus *in*side of a wooden casing built in this manner, you can combine the *strength* and *invulnerability* of an *iron* ship with the clean-bottomed, long, sea-going advantages of a coppered and copper-fastened timber-built ship.

ON ARMOUR-PLATED SHIPS, AND THE STABILITY OF VESSELS IN A SEAWAY, CONSIDERED IN RELATION TO THE PRINCIPLE OF THE LEVER AND THE LAWS OF MOTION.

By Mr. Barrass.

Mr. Chairman and Gentlemen,

It is proposed to discuss the question of the behaviour of vessels in a seaway, and to consider that behaviour in relation to the principle of the lever and the laws of motion, and by a process of consideration based upon the conditions which actually obtain when the vessel is at sea, to endeavour to arrive at more satisfactory results than those obtained by the geometrical methods which are in present use.

When a vessel has left the dock or the quiet river (the condition under which she has been treated by her architect) and has proceeded to sea, she has entered a new life, from the passive piece of gravitation in the dock she has become, as it were, a thing of life and action, —a body in motion, and as a body in motion will, no doubt, obey those principles of mechanics, and be governed by those laws of motion which rule universal matter, as may be observed if we but search for the causes in logical sequence of investigation, from the effects as they are presented to us.

From the nature of this proposition it will be desirable to state briefly the theory which prevails at present, and for what reason exception is taken to it. To pass in review the most prominent features of those labours which have recently extended the view of the subject, and then to explain how it is proposed to account for the behaviour of vessels in a seaway by the principle of the lever and the laws of motion, and by tracing the causes of rolling, and thereby the relation which is subsisting between the cause and the effect, that it may be seen more clearly how to ensure as far as practicable a steady gun platform—a vessel that shall roll as little as possible, both in extent of angle and number of times; for now that iron will, no doubt, take the place of wood in the construction of the Royal Navy, with heavy armour plates on the sides, tending to make the vessel roll through a greater angle, it becomes a desideratum to determine the first principles involved in the cause, that control the motions of a vessel in a seaway, that we may know how to deal with the subject, and be enabled to press into our service the full benefits which armour-plating may afford.

Before proceeding, however, with this inquiry, I wish to make a few observations on the story of the backings, and the iron *versus* wood question; for it appears to me that, captivated by the term cushion, wood backing threatens to run us into a rut, whence it may take a half-century of talk, and then only, perhaps, on the occasion of some national calamity, to drag us out, while no efforts should be relaxed in

condemning the tinkering and wasteful course of building wooden vessels to be covered with armour plates.

Wood backing is quickly acted upon by the shot, it yields readily to the momentum of the blow, because it is soft, but in this very act of yielding receives the whole momentum of the shot, and so permits the whole of the work of the shot to be spent upon destruction, the wood backing being crushed and splintered up, if not at the first, at any rate, with very few blows, when both the plate and the cushion are destroyed together, and the analogy to a cushion ceases, and any conclusion, therefore, which may be drawn from an analogy which does not exist throughout the whole of the circumstances, is clearly fallacious.

Iron backing, on the other hand, is not so quickly acted upon by the shot, because it does not act by being crushed up, but acts by yielding, by deflection to the momentum of the blow, like the deflection of a railway bridge on the load passing over it (Plate XV. Fig. 1). The only difference is that the one is a yielding by a crushing action, which soon destroys the material from which it is produced, while the other is a yielding due to the elasticity which is developed by the transverse strain on the shot deflecting the plates.

If these plates are connected together in such a manner as to secure a uniform continuity of strength in every direction, this most important condition will be obtained also; that for all impacts which do not deflect the plates to such a degree as to produce permanent rupture of the fibres, the shot can only give out one-half of its momentum, because as soon as one-half of its force has been given out upon the plates, and which they have stored up, there will be immediately an equilibrium of forces between the plates and the shot, and since a lesser force cannot overcome a greater force, the remaining half of the force of the shot expires with the expiration of its velocity, when the half of the force which has been stored up by the plates reacts upon the shot or its fragments, and throws them back again. This property of throwing back the shot* has been exhibited in a marked degree by all targets wherein iron has formed an element of the backing (Fig. 1).

The matter of wood and iron backing, then, may be said to stand thus:—For moderate impacts, from which neither the plates nor the wood backing would receive injury, and where the wood backing would continue to employ the function which has been assigned to it of a cushion, then the same result would obtain as that which is sought to be obtained for heavy impacts by an iron backing, for it is immaterial in the resistance-to-penetration aspect of the question, whether the shot be resisted, or have its blow softened by the crushing action of wood backing or the elasticity of iron plates, so long as neither are injured; and, therefore, it is a mere question of which material is injured most easily, or that which withstands the greatest amount of work, and if any system is calculated to meet a heavier impact than another, it cannot be doing wrong to apply it generally.

* This occurs up to a given high velocity of shot, after which the time is too short to admit of reaction.

Fig. 3.

Diagram showing the present Geometrical Method of considering the stability of Ships.

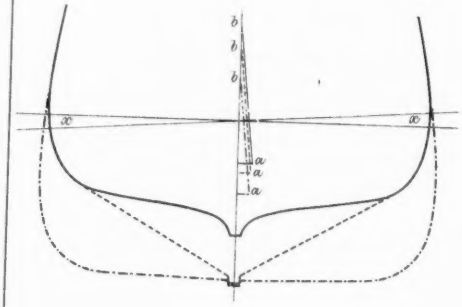
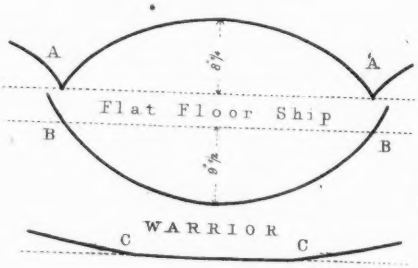


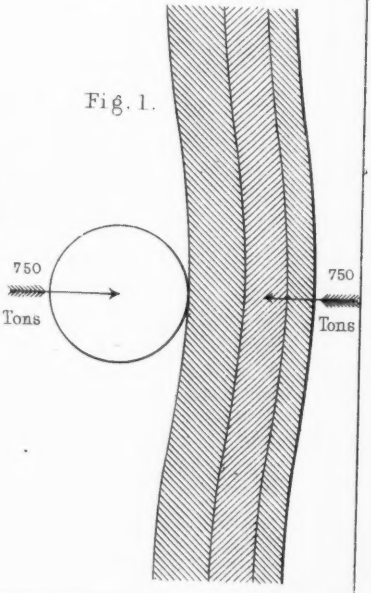
Fig. 2.

Orbits of Centre of Buoyancy of Rising Floor Ship.



Diagram, showing Iron Backing stopping the Shot when half its force has been delivered.

Fig. 1.



Turning to the iron *versus* wood question: it is said the "Prince Consort" has suffered no damage from her unlucky advent in the Channel. Having arrived in quiet water again, and the straining action having ceased, the joints closed up again, and the leakage stopped; it is made out that she shipped all the water. If a wooden built ship in herself creaks, twists, and opens her joints in a seaway, what will she be likely to do with 600 or 1,000 tons of armour plates hanging upon her sides. Consider for a moment the heaviest masses we have in motion on land, a fly wheel of a rolling mill, or a beam of a pumping engine, weighing from 20 to 30 tons only, and see the proportions and continuity of strength, that must be preserved in every detail of construction that the integrity of the structure shall not be vitiated by a weak point, and then turn to these wooden vessels, armour-plated, and reflect upon them in a sea-way, not put in motion like the almost uniform motions of machinery, but pitched about first one way and then the other, with a mass of iron of the weight of one of the Britannia tubes hanging upon their sides; and consider the details of construction which the ship carpenter has to depend upon to keep the structure together; for example, the coaks at the butt joints of the futtocks, which merely keep them in place, but give no cohesion and no transverse strength, the attachment of the beams to the sides, the knees, fastenings, and riders, fixed with spikes or bolts, which however strong in themselves, only serve to strengthen the ship by the bearing area, which the wood offers to the bolt—a soft material pressing against a hard one—the bolt pulling for itself an oblong hole in the timber long before either the bolt or the timber which it is fixing has received one tithe of its working strain. Putting these things together, and conceiving the strains that must be thrown through the beams and sides of an armour-plated wooden-built ship to pull her out of shape at every roll in a sea-way, it certainly appears unreasonable to expect that they can preserve their form and efficiency for any length of time under such circumstances, while it is clear, that if the Royal Navy is to march with the times, to press into its service the resources of modern industry and modern improvements, and is to meet modern necessities, it must be built wholly of iron or steel, but applied in such a manner as to meet its special requirements, and when that is done, I will venture to affirm that there is no property you can fairly claim for a wooden vessel, that cannot be reproduced in an iron one, with a fourfold higher ratio of efficiency.

With respect to the fouling of iron bottoms, there is in this Institution a model of an invention which seems quite adequate to remove that difficulty: viz., to fix thin planks over the bottom, and copper the planks; the planks could be well bedded in marine glue or stiff red lead paint, and secured with coach screws from the inside.

Proceeding to Stability in a Sea-way.—The theory which obtains at present for determining the stability of ships was introduced by Bougour, in 1746, as a measure of the stability of *floating* bodies, and is illustrated in its application to ships by a geometrical figure, in which the ship is supposed to be heeled over a very small amount, by drawing a new water line at a small angle with the first horizontal one,

and thus exhibiting, that in heeling over there would be a triangular prism emersed and a similar one immersed (Fig. 3). These prisms were taken as right lined figures, and the centres of gravity therefore of each triangle, at one-third of its height from the base or extreme breadth line. And from a righting moment based upon the transfer of these solids of emersion and immersion on supposed rolling, another righting moment was determined by drawing a line parallel to the inclined water line from the centre of buoyancy, and setting off on that line a distance which, when multiplied into the total displacement, gives an equivalent righting moment to that of the triangular prisms near the water line, and from this new centre of displacement (*a a a*), a perpendicular is erected at right angles to the inclined water line, and where it intersects the middle line of the ship, this point is called the meta-centre (Fig. 3, *b b b*), and its height above the centre of displacement, is the measure of the stability of vessels used in France, and on the continent generally.

This method of estimating the stability of vessels is liable, in its application, to grave errors. Ships may have a widely different form —may have a deep or a shallow section, or have a rising floor, and the stabilities of each be as wide as the poles asunder, and yet their stabilities estimated in this manner would be much about the same, seeing that at the small angle at which the heeling over is calculated, ships, at and about the water line, differ inappreciably (Fig 3).

Atwood, however, showed clearly enough in the Philosophical Transactions for 1796-1798, that the effort of a vessel to return to her upright position was due to the centre of displacement of the whole geometrical form of immersion after inclination, and the result of Atwood's theorem is multiplying the displacement or weight of the vessel into the horizontal distance between verticals falling through the centres of gravity and of displacement for the righting moment (Plate XVI. Fig 4). Atwood calculated the centre of displacement for several vessels at an angle of 7°, a process and mode of treatment he has since been so much followed in by English naval architects, as to justify its being entitled our system, though it still retains the geometry and nomenclature of the meta-centre, and the height of the meta-centre above the centre of gravity is considered the measure of stability.

There are many interesting points in the geometry with which this subject has been associated, which there is not time to introduce here, but these two statements may be taken as representing the theory of the stability of vessels as held by naval architects.

As applied to the stability of *floating* bodies in still water, the theory is satisfactory enough, but a vessel in a seaway is not a floating body only depending upon her flotation, as she was in the dock, or as she was represented on the sheet of drawing-paper by her architect; and it is in the application of this theory of floating bodies in still water, to vessels in a seaway, to which exception is taken, as not touching the conditions under which the vessel is then placed; indeed, so far from there being a true analogy between the conditions under which the theory is applied and the conditions under which a vessel is situated in a seaway,

Fig. 4.

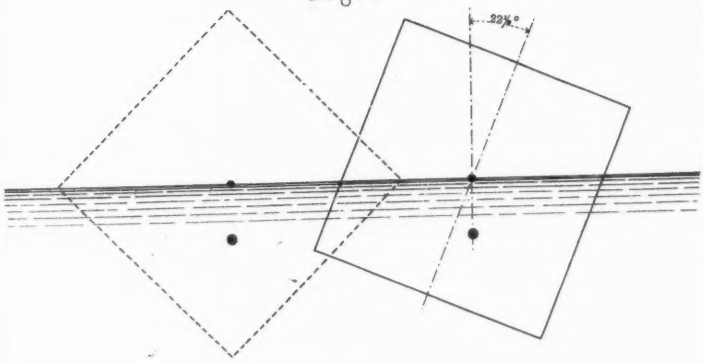


Fig. 5.

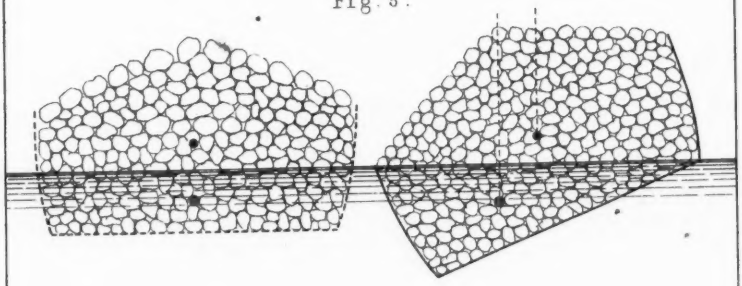
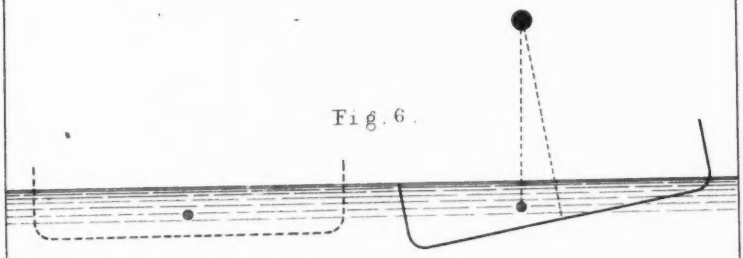


Fig. 6.



J.R.Jobbins

they are absolutely reversed. Instead of the vessel being put in motion, or heeled over by an external force, with the water at rest and resisting the motion, the water is in motion and puts the vessel in motion, and that uneasiness in a seaway is not only the penalty of great statical stability, as Sir William Symonds has put it, but the penalty also of a false logic, a logic which accepts the property of the water when it is still, but ignores the same property when it is in motion, for the stability on paper or in quiescent water is derived from those very proportions which conduce to instability or excess of motion in a seaway.

Passing now to the paper on dynamical stability by Canon Moseley, in the Philosophical Transactions for 1850, the author proposed to consider the amount of work which would require to be done upon a vessel to heel her over.

If a force be applied, say to the masthead, to heel a vessel over, the force, or the mean pressure (for it will be a variable one), multiplied into the space through which the force has passed, the product will be the work done, the dynamical effect required to heel the vessel over that amount, and such as might be done by the blow of a wave, or a gust of wind; and it was proposed to measure this work by the product of the weight, and the sum of the spaces through which the centre of gravity was raised, and the centre of buoyancy lowered, the author observing that the subject had hitherto been viewed only in the point of view as to whether any given position be one of stable, unstable, or indifferent equilibrium, or that which determines what pressure is necessary to retain the body at any given inclination.

Experiments were made at Portsmouth to test the reliability of the formula based upon these considerations. In those with the triangular model the differences between the dynamical stability as calculated from the formula, and those determined by experiment, are given in the following table:—

Angle at which the model finally rested in statical equilibrium.	Angle through which the falling weight deflected the model.	Differences between the calculated and experimental results.	Leverage between the centres of buoyancy and gravity.
8°	15½°	1·29 per cent.	0·645
12½°	23½°	3·73 „	
13	24	19·16 „	
13	25	31·34 „	1·149

which shows that when the model was deflected through 15½°, the difference was only 1·29 per cent., but increased in a much greater ratio than the increase of angle of deflection, the difference between

23½° and 25° being 28 per cent., and indicating that at about 2 more degrees of deflection the difference would be about 100 per cent., and that there must be absent from the formula some fundamental element in the inquiry.

The formula takes no cognizance of the lever by which the work is done in this case. The lever is the horizontal distance between verticals falling through the centres of gravity and of buoyancy. It is clear that a vessel might have double the beam, and require double the amount of work to be done upon her to heel her over with the same amount of rise or fall of the centres of gravity and of buoyancy, while the formula for dynamical stability would make both alike; or it may be put in another light, a form of displacement might be worked out in which the whole of the work done would be expended in constituting the aqueous lever which is forming itself to resist the heeling over, with a centre of buoyancy neither rising nor falling, and perhaps with a centre of gravity falling and assisting it. Dynamical stability in still water, however, being governed by exactly those conditions which govern the statical, the one will always be in the same ratio as the other in different ships, and Canon Moseley's formula may be said to leave the subject just where it was, but under another name.

The learned author also entered into an elaborate mathematical investigation as to the time of rolling or periodic time, in which the ship is considered as an oscillating body, and its behaviour in a seaway is sought to be accounted for on the principle of the pendulum.

These considerations, however, appear to be based upon an erroneous analogy, though not so erroneous as that of Chapman, who considered the vessel as a pendulum, whose point of oscillation is the meta-centre, and centre of oscillation the centre of gravity. I believe that a little further reflection will show that the question does not belong to the department of central forces at all; indeed, I do not see how it can possibly belong to it, for a vessel in a seaway cannot be said to have any centre or axis of revolution or oscillation. It is true the centre of gravity is endeavouring to roll round the centre of buoyancy, but it is always slipping away into another position, both laterally and vertically, the radius of gyration ever varying; and to endeavour to account for the behaviour of vessels in a seaway upon such an hypothesis, seems to me to be quite hopeless, and as Dr. Woolley has truly observed in his able opening address at the Institution of Naval Architects, "the mathematical expressions for the time of rolling afford very little clue to the behaviour of a vessel. Ships in which this element is nearly, if not quite, the same according to calculation, are as wide as the poles asunder in their actual performance at sea, so that while one in a heavy sea rolls with considerable ease, another is so uneasy as seriously to endanger her masts, and in order to bring the case within the grasp of mathematical analysis, so many assumptions and limitations are necessariily introduced as to ignore the form of the vessel altogether, except just about the water line. I believe," continues Dr. Woolley, "the calculated time for the 'Vanguard' and 'Canopus' differ very slightly." You know their relative behaviour. Their solids of immersion at an angle of 7° are as

5 to 1 with a breadth of 57·6 feet in the "Vanguard," and of 51·8 feet in the "Canopus," when heeled over, and with this greater breadth and solid of immersion (and, therefore, the probability of the whole geometrical form of immersion partaking of that character, and giving a greater lateral traverse to the centre of buoyancy) we seem to have indicated to us why the "Canopus"* rolled slowly and easily, while the "Vanguard" rolled very much more quickly and uneasily, and why those very properties which give great statical and dynamical stability in quiet water, upset all calculations as to periodic time, and produce a reverse result as to stability when the vessel becomes a body in motion actuated by the waves.

It will be desirable now to review briefly those hypotheses which have been appended recently to this subject, namely, the supposed motions of the fluid particles in waves, and the supposed configuration of the waves to some mathematical curve, and the supposed periodic time of transit.

With respect to the motions of the fluid particles in waves. If we think upon the transmission of force as illustrated by the old experiment with elastic balls, and bear in mind the mechanical property of water of being competent to pass a great force through its particles, and combine these with a consideration of its being under the influence of the law of gravity in the vertical direction, then the whole phenomena of wave motion is easily explained. Wave motion is the motion of a force only passing through the particles. The wind blowing in a horizontal direction communicates its force to the fluid particles, but by their close contact and resistance to receive motion in that direction are driven up, the horizontal force exceeds the gravitating force, until they have been driven up high enough to balance it and pass it on, and so giving direction to the wave force. The direction in a gale being that of the wind, in a calm that of the beach,—the horizontal line of least resistance to its transmission; but in a cross and troubled sea, or behind piers and breakwaters the forces meeting, dividing and playing through the particles in sudden and ever varying movement, sometimes two great forces meeting, and the resultant producing a much higher wave than usual, and with the fall of the wave all trace of it has vanished from the spot; where we saw the huge wave we now see comparatively smooth water, for with the fall of the wave, the vertical force which was the resultant of the forces meeting, is again divided up and sent into other places to repeat the operation, and that which has sometimes been considered an optical illusion, becomes, when accounted for, a solemn and instructive fact.

The solitary wave traversing the ocean, is a force which has received its direction and amount at a distance from the place in which it is met, it passes through and leaves the particles in the same horizontal position in which it found them, and without having impressed its hori-

* Captain Fishbourne, R.N., who revised this paper for Mr. Barrass, after his departure from England, states that "'Vanguard' rolled both *deeper* and faster in a seaway than 'Canopus.' The mistaken views arose from overlooking the differences of the amount of vis viva, arising from the two forms: this vitiates all calculations." —Ed.

zontal motion upon them; and if the wave be so high that the ship breaks the contact of the particles, then, like the last ball in the experiment mentioned, the last particles take up the motion of the force and momentum, and a blow is the result.

The motion of fluid particles, then, in wave movement, is simply an up and down one (as sailors have long considered it to be), but having a tendency to slide down the side of the wave, according to the resultant of gravity and fluid pressure, and the time there may be to bring these forces into action.

The behaviour of the vessel, therefore, cannot be influenced by the behaviour of the fluid particles in wave motion, because they are governed by the same laws and conditions as the vessel herself, she riding freely up and down and over the wave, but having a tendency to slide down the side of a wave in the direction of the resultant of gravity and fluid pressure. Captain Fishbourne informed me that this tendency was most distinctly felt on board rising floor ships, jerking bodily down when on the side of a wave. An inspection of the diagram will explain it as being due to the parallelism of the floor of this class of vessel, with the surface of the wave when on the side of it.

How far the wave forces may pass on so uniformly, both in amount of force and period of time, as to present the repeated configuration of a geometrical curve, and to what extent any theoretical conclusions could be based upon such considerations, your own practical experience will have informed you.

The proposition of Mr. Froude, however, calls for a more detailed review.

The author, on the strength of some experiments with a floating plumb bob, proceeds into a laborious and elaborate mathematical investigation, which results in proposing what appears to be more a question of mere ballasting than a question of the science of naval architecture, viz., to manage and control the behaviour of vessels in a seaway, more by the disposition of ballast than by the form of the ship, stating that he is satisfied if you take two ships differing as widely in their forms as those of the "Albion" and "St. Vincent," and load them so that they have the same periodic time in still water, they will perform almost identically when rolling in a seaway, and that all ships having the same periodic time or period of natural roll when artificially put in motion in still water, will go through the same series of movements when subjected to the same series of waves, whether their stability in still water be due to breadth of beam, or to deeply stowed ballast.

The experiment with the floating plumb-bob (Fig. 6), and which the author considered as exhibiting his fundamental law which governs the motion of a ship on waves, was made with a small cork-float about four inches diameter, like a life-buoy with a mast fixed obliquely in one side of it, with its apex perpendicular over the centre of the float, and having a small plumb-bob suspended from it; and because the plumb-bob remained central to the float when it was disturbed by waves, the author proceeded to consider the conditions of a floating

body to be the same as surface fluid particles, and to assign them to specified dynamical conditions which the position was supposed to impose upon them.

It will be observed that a float with a loaded mast fixed in one side of it becomes in disturbed water a variable lever of the second order with respect to the fluid pressure to move it, on the transit of a wave; the power of the wave water to move it, being directly as its pressure when under the mast, but as the wave passes on under the float, the leverage of the fluid pressure to move it, is increasing, until when the mean pressure of the wave has arrived at the opposite side of the float to that in which the mast is fixed, the leverage of the water to move the loaded float is increased 100 per cent. to move it quicker or in half the time at this period of the wave transit, than when it was underneath the mast, so that the cause of the plumb-bob remaining central to the float in disturbed water is a mechanical one, and the mast has a tendency to make two complete vibrations for one wave transit, and when the flexibility of the cork and mast are considered, the variability of the leverage of the disturbed water, and it not having a rigid fulcrum to work upon, it is not to be wondered at, that the masthead flew about, and did not give the plumb-bob time to do otherwise than to remain central to the float.

I am far from wishing to depreciate Mr. Froude's labours; indeed, I am ready to acknowledge having been much instructed by them; but from the premises to the conclusion and throughout all their argument, they appear to me to be either illogical or in absolute error. They start upon an experiment which I have shown to have been misinterpreted, and are continued upon assumptions which are only permissible because they are not absolutely impossible, whilst strangely enough, they end in but one practicable measure, that of favouring a maximum beam; so that, taking the author's conclusions on his own terms, he ends as he began, with recommending that very condition which was known to give great statical stability in quiet water, and the instability in a seaway of the sailor. As to the idea that a steady vessel can be made out of a bad form, or that the form is immaterial, and that in the case of an armour-plated ship (with the heavy armour plates on the extreme width and the engines and boilers nearly on the extreme bottom) the effects of these weights on the motions of the vessel can be modified or neutralised in a bad form of vessel by a few tons of ballast placed wherever you like, I must confess that, to my mind, the proposition seems an absolute delusion.

I now proceed to explain how to account for the behaviour of a vessel in a seaway on the principle of the lever and the laws of motion.

When a vessel is rolling in a seaway, a lever is formed on each side from the resultant upward pressure of the fluid, the centre of buoyancy has acquired a position in this rolling over which gives it a command—a leverage to move the vessel, and to cause the motion of rolling in disturbed water. That is to say, though there is not a rigid fulcrum, in the usual significance of the term, but the upward pressure of the particles are alternately becoming the power applied, and the

fulcrum, as the one exceeds the other on the rolling of the vessel from side to side; and the distance, therefore, which the centre of buoyancy traverses from side to side on rolling will be a leverage (Fig. 7, 8, 9, Plate XVII) presented to disturbed water to put the vessel in motion.

In no department of the inquiries which come before this Institution have the labours of Captain Fishbourne been more fruitful of useful results than in this upon which I have the honour to address you, and from him I have to acknowledge receiving valuable practical assistance and counsel in the preparation of this paper. It was to his published lectures on naval architecture in 1846, that I owe the knowledge of the views of the "Naval Architect" not meeting the requirements of the fighting sailor, and the inducement to look into the matter.

I was not aware, however, that Captain Fishbourne in subsequent papers had introduced such a mode of viewing the subject as referring the influence of the passing wave on the vessel to the principle of the lever, or I should have left the subject in his hands; but having embarked in it, I will state the results. My conclusions, it may be observed, were drawn from small experiments and a process of reasoning. Captain Fishbourne's conclusions are based upon practical experience at sea, and demonstrated by the facts and figures given in the following table of recorded results of the actual performances of vessels of the Royal Navy, and which prove beyond doubt and without exception of example, if even it could not be proved logically and mechanically, that a beam relatively great to the depth of displacement, is that very condition which goes far towards making a rolling ship in a seaway.

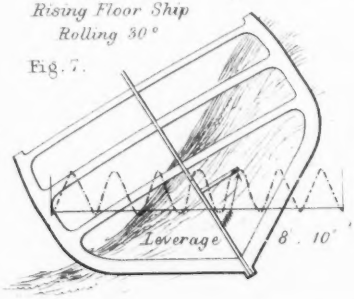
Table showing the relation between the beams of vessels and their behaviours in a seaway:—

Name of Vessel.	Half breadth.	Depth.	Difference.	Angle rolled through.	No. of times per minute.
Albion.	30′ 0″	24′ 4″	5′ 8″	49°	13
Rodney.	27′ 0″	24′ 8″	2′ 4″	27°	8
Queen.	30′ 0″	25′ 3″	4′ 8″	20°	7
St. Vincent.	26′ 9″	25′ 3″	1′ 6″	13°	5
Trafalgar.	27′ 6″	25′ 3″	2′ 2″		1
Superb.	28′ 6″	24′ 7″	3′ 11″		3
Canopus.	25′ 6″	23′ 10″	1′ 9″		2
Hecate.				10°	8
Antelope.				5°	4

Diagram showing the Rise and Fall and the Leverage of the Centre of Buoyancy in a Seaway of

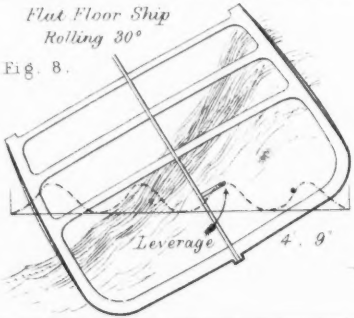
Rising Floor Ship
Rolling 30°

Fig. 7.



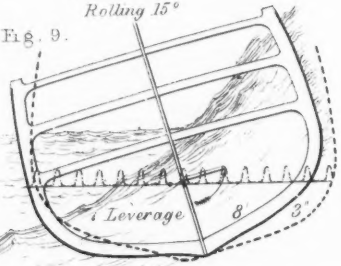
Flat Floor Ship
Rolling 30°

Fig. 8.



W a r r i o r
Rolling 15°

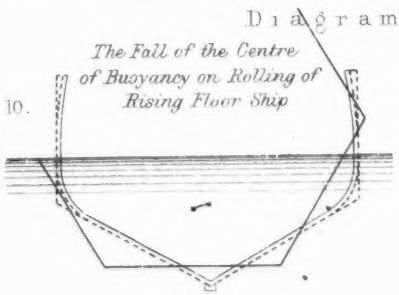
Fig. 9.



Diagrams showing

The Fall of the Centre of Buoyancy on Rolling of Rising Floor Ship

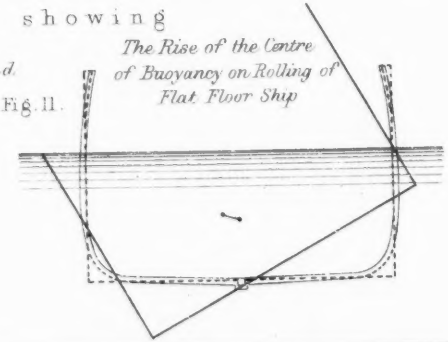
Fig. 10.



and

The Rise of the Centre of Buoyancy on Rolling of Flat Floor Ship

Fig. 11.



J.R.Jobbins

If anything more were wanted to prove the truth of the argument, it is supplied in the fact of a vessel rolling more when light than when laden, for it must not be supposed that the water "per se" has a greater power of flotation then. The mind must not admit the idea that because the vessel is lightened, the water will necessarily have more command over her without a mechanical cause other than its buoyancy, for just in proportion as the vessel has been lightened, so has the floating power been reduced also; and if a vessel when lightly laden is rolled about by a sea more than when it is heavily laden, it must be due to the floating power having then a greater proportionate command over her, a greater leverage with a lesser weight to put her in motion when light than when laden.

Now, if we apply the present theory to the same vessel when light and when laden, we find that though the centre of gravity has been raised by her being lightened, the meta-centre has been raised also, so that virtually the theory would give the vessel the same stability, when it is so well known that the contrary is the result in disturbed water, and the mechanical cause of it seems clear enough. If a vessel has been lightened on her voyage by a foot of her draught, the mechanical power of the waves to put her in motion would be the same as if her draught had been preserved, and two feet had been added to her beam. If she were lightened by two feet of her draught, the mechanical equivalent would be as if four feet had been added to the beam; and if she now draws three feet of water less than when she started, the waves will have the effect to put her in motion as if six feet had been added to her beam.

The simple fact appears to be this: that the course of naval architects has been, is, and I fear will be, until they are shamed out of it, to consider the water and vessel at rest only, allowing, as it were, the water to have the power to float the vessel when at rest, but ignoring the power of the water to put the vessel in motion if it be disturbed, forgetting that the conditions are reversed in passing from quiet to disturbed water, and that what was the lever in the first case to resist the heeling over, becomes in the second the lever to put her in motion.

Let me be understood as taking no part with those who consider that a large amount of ignorance prevails amongst the professors of this science, knowing that the highest attainments are requisite for its pursuit, and remembering the channels which a long current of thought and treatment tend to deepen and render difficult of being diverted afterwards.

But it does appear that they committed an oversight in letting their theory get into such a rut, while they have been somewhat unwilling for any one to help them out of it. Now, they might be very well sure that if their theory was worth anything, and rested upon a foundation which they relied upon themselves, and could communicate to others, and be relied upon by sailors, their views would not be questioned, and my appearance here would be inexcusable. But what do we find? One professor for a flat floor, another for a rising floor, one for a barrel bottom, and another for a cigar shape altogether, while one would always have a clipper section totally irrespective of first con-

siderations; and whether the vessel was simply to sail fast or to carry a broadside armament, one for a full fore body, and another for a full after body. The former not having a reason of his own, goes to nature for one, and cod's heads and mackerel tails become the standard for the forms of ships, and not unfrequently a small model dressed down here, and shaved down there, until it pleases the eye, is the theory employed. Is it to be wondered at then, seeing these things, that this subject engages the attention of inquiring minds, whether they may belong to the profession or not?

But the fishy analogy is somewhat amusing, inasmuch as a fish wags its after body and tail to propel itself quickly, and if any analogy subsisted in the view, the ship should wag her after body and tail also, but as the ship does not do that, the forms of fish are no clue as to what ought to be the forms of ships. If we endeavour to interpret nature on first principles, it may be that since a fish propels itself by a muscular exertion from the shoulders to the tail, and its power, therefore, to work the after body being inversely as its length and directly as its depth and breadth, nature tends to produce that muscular development which enables the fish to fulfil its functions on mechanical principles, and it is supplied with a good leverage and quantity of muscle where it is wanted—at the shoulders.

I have now to propose the consideration of a vessel in a sea-way as a body in motion, and as a body in motion subject to those laws of motion which are governing all matter in motion.

When a vessel is rolling in a seaway, the centre of buoyancy in passing from side to side, may rise or fall in doing so, and the centre of buoyancy being the centre of support, if the centre of support falls on rolling, then the accelerating force of gravity will come into action, tending to continue the rolling (Figs. 10, 11). Thus the centre of gravity of the vessel is rolling through an arc, and the versed sine of that arc may be taken as the measure of the accelerating force of gravity to continue the rolling; but if the vessel in rolling, has, as it were, lost her point of support, then the vessel is permitted to continue the rolling, and the amount of the accelerating force of the gravity of the vessel to continue the rolling, may be measured by the versed sine of the arc of the centre of gravity, plus the versed sine of the arc of the centre of buoyancy; and thus if the centre of buoyancy falls, it permits the vessel to roll through a larger angle than it would do, if the centre of buoyancy rose with the rolling, and presented a retarding force to the motion.

I am doubtful whether I may have succeeded in conveying the proposition to your minds; the subject is a subtle and difficult one, and I have not yet been able to devise a moving diagram to illustrate it, which it would require to do, to demonstrate it clearly; but I think if you will conceive, that if a vessel's geometrical form of displacement is such, that in the act of rolling, the water surrounding her has by the action of gravity given out a force—a resultant fluid pressure at a greater height, produced a dynamical effect, a force moved up through a given height, and that the effect upon the vessel is the same as if an hydraulic press had been acting on each side of the vessel at each

roll, and thrusting out its ram with a pressure equal to the weight of the vessel, and through a space equal to the rise which may be given to and at the centre of buoyancy, then you will form some conception of the enormous power which a vessel may extract from the subtle element in which she is rolling, if you but give her a geometrical form which will enable her to do so, and make her a steady vessel.

Thus, suppose the displacement of the "Warrior" to be 10,000 tons, that she is rolling ten times a minute, and that if by flattening the floor, the centre of buoyancy was made to rise six inches higher than it does, or not to fall so much by that amount; then multiplying these together, and by 2240, the number of pounds in a ton, we have the dynamical effect of 224,000,000 lbs., raised one foot high per minute, and dividing by 33,000, we have a power equal to that of 6,787 horses, that would be given out by the gravitating force of the adjacent water, to keep her a steadier vessel, if her geometrical form of immersion were such, that in the act of rolling, the resultant fluid pressure, the centre of buoyancy, rose up against the roll six inches more than it does.

Referring to the diagrams (Figs. 7, 8, 9) in illustration of the point, they show a rising floor vessel, a flat floor vessel, and the "Warrior," one-sixteenth the full size, all of the same beam and draught. In the rising floor vessel, the centre of buoyancy falls $8\frac{1}{4}$ inches through 30° of roll, when it suddenly commences to rise, as shown by the orbits of the centre of buoyancy in the diagram (A A Fig. 2). This indicates that vessels of this form will be easily set in motion, roll through a large angle, and quickly, but will be suddenly arrested near the termination of each roll, checked with a jerk, as it were, enough to throw the masts overboard, and then as quickly sent back again, for just as the centre of buoyancy has commenced to be effective to control the rolling, it has then acquired a great leverage to return the roll quickly.

A phenomenon of frequent occurrence also bears upon the point. When quick-going steamers are passing over shallows, waves are raised at the bow and stern by the pressure from amidships, the vessel then loses a portion of her displacement amidships, but gains it forward and aft by these waves which are raised there, and in proportion as the buoyancy has been increased forward and aft, and lost amidships, the vessel has been made temporarily of a peg-top form, from losing the displacement where the floor is flatter, the centre of buoyancy falls on rolling, and, therefore, she rolls easily.

The incident related by Sir Heron Maxwell also might be mentioned, that when the "St. Vincent" was perfectly steady, the "Albion" was lurching over in a quiet sea in the Bay of Biscay, and shipping 100 tons of water through her lower ports, to the affright of the Admiral Commanding.

The new armour-plated frigate, the "Valiant," judging from her section, will be a second "Albion," though perhaps not quite so bad.

In the flat floor vessel, the centre of buoyancy rises $9\frac{1}{2}$ inches through 30° of roll and still continues to rise, as shown by the diagram (B B Fig. 2). This indicates that vessels of this form will always be

steady, roll through a small angle, and slowly as well, because the centre of buoyancy is always exercising a retarding force to the roll of the vessel, while the form of displacement developes only a small lever to induce motion in disturbed water.

Naval architects will tell you that this will make a most unsteady ship, from the bodily rise and fall of the centre of gravity which the rise and fall of the centre of buoyancy may give, or which the form of immersion after heeling over may give. An argument which not only appears incorrect, but it is the veriest rubbish, as if the bodily rise and fall of the centre of gravity as exhibited by their geometrical figure in still water can be compared to its being thrown and pitched about in a seaway ten times as many feet as the drawing will exhibit inches. Besides the centre of gravity is an abstraction, while some of its items might be so situated in the ship as to take away all grounds for this argument. The stability of a nearly complete homogenous cylinder wholly depends upon the bodily rise and fall of the centre of gravity.

Taking even a common sense view of the matter, apart from theoretical grounds, does it not appear reasonable to expect a vessel with a flat floor to be steady in a seaway, seeing that, on her rolling, a large nearly flat surface is pressed downwards at a maximum depth, and therefore exercising a maximum effect to resist the motion; while in a circular or peg-top form, that resistance to the motion is lost in proportion to the vessel partaking of those forms, when instead of a nearly vertical pressure at a great depth, it becomes more of a side pressure at a lesser depth, and for both reasons not so calculated to resist motion in a seaway as a flat-floored vessel.

In ships of an intermediate form, their behaviour in a seaway will be of an interesting nature. The centre of buoyancy of the "Warrior" neither rises nor falls within a roll of 15° (C C Fig. 2). This indicates that vessels of the "Warrior," "Canopus," and all those forms approaching to or possessing the barrel bottom, will roll through a lesser angle than the peg-top class, but through a greater angle than the flat-floor class, their motions will be much easier than the former, but not easier than the latter.

Recapitulating, in conclusion, the results which flow from these considerations:

1stly. The present method of treating the stability of a vessel as that of a floating body in still water, is illogical and does not touch the question of the stability of a vessel in a seaway, inasmuch as in still water it is the water which is resisting the heeling over on the application of an external force, while, when the vessel gets into a seaway, the conditions are reversed, the water is then in motion and is putting the vessel in motion, without the presence of and without any reference to the force by which the heeling over was effected in still water, and therefore that form of body which would offer the greatest stability in quiet water, will present it to put the vessel in motion when she has passed into disturbed water.

2ndly. The centres of gravity and buoyancy ever moving about with every varying condition of loading, trimming, pitching, rising up

and falling down, and rolling in a seaway, the problem can scarcely be considered as belonging to the department of central forces, and therefore any investigations based upon the principle of the pendulum cannot but be questionable, if not erroneous; while if we consider upon what actually does take place of the centre of buoyancy forming a lever of the second order of which it is the power, the centre of gravity, the weight, and the fluid pressure on the other side the fulcrum, and that all these are in motion and with a centre of buoyancy, either rising or falling, either using or losing the power which it may command. It would appear that the principle of the lever and the laws of motion are logically applicable to the case, and though it will still be beyond the grasp of mathematical analysis, at least so far as to determine absolute quantities, they are sufficient to account for the behaviour of vessels in a seaway.

3dly. That for fighting ships where accuracy of fire is necessary, and therefore a steady gun platform, the floors should be flattened first, and then reduce the beam as much as is practicable.

I now submit to your judgment how far these observations coincide with your practical experience on board ship at sea, and how far you may consider the course indicated to be calculated to ensure you the full benefits which armour-plating may afford, and that its utility shall not be nullified by a bad form of vessel, and if, in making these observations, I have at any time spoken with more assurance than my experience and these circumstances would warrant, I trust you will attribute it to the instinct to clothe the language of a firm conviction in the language of earnestness upon a serious and important subject, rather than to forgetting the assembly which I have had the honour to address.

Mr. Michael Scott, C.E.: To my mind this is a subject of such intense difficulty that one cannot speak upon it without some consideration. If the discussion were to be adjourned I might perhaps be prepared to make some observations upon the subject. The paper has been to me very interesting, but it is quite obvious from its very nature that it is difficult to follow the argument, or to criticise any of the statements made in it, without some time for consideration. However, there are one or two points that I might notice. One is with respect to the form of the fish as distinguished from the form of a vessel. The fish is a wholly immersed body; the ship is only partially immersed. I quite agree with the author, so far as I understood the paper, that it is possible to draw very erroneous conclusions from the form of a body wholly immersed, such as that of a fish, if it be intended to apply it to a vessel which is floating on the surface. Another point that struck me was, with respect to the motion of water in a wave. We recognise waves of different characters. In one wave, the motion is what the author has described, very much to leave the particles in the same horizontal position that they were in before disturbance. In another form of wave it is not so; the water is absolutely in motion, and it exerts very considerable power on any body that is floating on its surface at the moment. I do not know that I quite understood the author's criticism on Mr. Froude's theory. I

heard Mr. Froude give an explanation of that theory, and it appeared to me to be very satisfactory. But it is confessedly a subject of such difficulty, that there is room for a wide divergence of opinion; and I think more might be learned from the practical experience of naval officers, with respect to vessels of various forms, that would be more interesting to this Institution than anything I could say upon the abstract question of theory.

Captain E. G. FISHBOURNE, R.N., C.B.: I suppose I ought to make some remarks, as I have been alluded to, and more especially as the last gentleman who spoke seems rather disposed to affirm the correctness of the views of Mr. Froude. The tables on the wall are founded upon actual experiments, I would rather say upon observations than experiments. ["Table showing the influence of beam upon the behaviour of vessels in a sea-way."] These ships were under similar circumstances when the angle of roll was taken. The "Albion" rolled 49°; the "Rodney," 27°; the "Queen," 20°; the "St. Vincent," 13°. In the next column you will observe the number of times that they rolled in a minute: the "Albion," 13; the "Rodney," 8; the "Queen," 7; the "St. Vincent," 5; and so on. Now the proposition of Mr. Froude is, as stated in the paper:—You may take any description of vessel, and by the adjustment of the weights you can correct any defect of rolling. That is to say, if she should roll too quickly, you can adjust that by raising the weights, so that she shall roll more slowly. But as a necessary consequence of so doing, she will roll through a larger arc. If she rolls too slowly and through a larger arc, then you can lower the weights, and the consequence is you will reduce the arc, but you will increase the rapidity of the roll. Now, in the case of the "Albion," you have got two irreconcileable things: she rolls through the largest arc, and she rolls the most quickly. Now put in practice Mr. Froude's principles. Look, for the moment, simply at the fact of her rolling 13 times in a minute. That is too fast, so you raise the weights, and, immediately, that which is already too great, viz., her depth of roll, will at once be increased. The real history of the matter is simply this, as is too much the case at the present time, mathematics and common sense, or practical knowledge, have been divorced. I have a great respect for mathematics, but it is only when they are in good hands. Mathematics are very simple in operation; the steps are very short, and any person may be taught to take all the steps; but the great difficulty is, in the application, or having got your answer, to know how to read it. Unfortunately, without a practical knowledge, or without common sense, as a rule mathematics cannot be satisfactorily applied or understood, which is the case in the present instance. Mr. Froude has made an experiment in a tin dish; to this exceptional kind of experiment he has applied his mathematics, and he has got a result which really means nothing. Now, if the statement respecting the rolling of these ships be true, and I can have no doubt about its truth, for the officers had no theory to support,—(the signal was made by the Admiral, "Take the number of the rolls and take the angle of the rolls," and they were taken and recorded, and the result returned to the Admiralty)—if that statement be true, and

you cannot for a moment imagine that it does not represent existing facts, then if you apply this theory of Mr. Froude's, you at once see its absurdity. It reminds me of a story that I once heard of a boy who demonstrated that the square of the hypothenuse of a right-angled triangle was equal to the sum of the square of the other two sides. He was not very bright; he learned to get the orthodox proof off by heart, but he drew a figure that was altogether different from the proposition he had to prove. He went off very glibly with his proof, then said, "Well, I have proved it, but I don't believe it." Now, I believe, if people were as honest as that boy, we should have such an acknowledgment with respect to many results; that there is not, I believe, simply arises from the absence of practical knowledge of the subject. Architects have undertaken to design and to build ships without practical knowledge of the subject. They ignore that altogether, while, on the other hand, sailors have been inclined to go in the opposite direction, and say, "Because I have been at sea and have got practical knowledge, I do not need any architectural knowledge; I do not need to understand the principles of mechanics, nor do I need to understand the theory of naval architecture." I believe the truth is, as Mr. Scott said, we want a combination of the two things, mathematical knowledge, and common sense, or practical knowledge applied to that. I believe this to be a very important question, and that it has been treated very satisfactorily by Mr. Barrass. I am quite satisfied that if anybody will take his paper and examine it quietly, he will see it is simple and plain. It is not a subject that is at all difficult, put in the way it is. It has been treated in a plain, common-sense way, which anybody of understanding may comprehend if he will only give himself a little trouble and very little time to study it. I am quite sure that if that be not done, and we are to be led away by the great mathematical talents and knowledge of such persons as Mr. Froude, we shall be landed in the greatest absurdities, and our ships will be utter failures. I believe we have already gone a long way in the wrong direction, and I consider the results will be very serious. Many of the points in Mr. Froude's theory it would be hardly fair to notice here, because they have not been referred to in the paper; but those which have been brought forward I have remarked upon, as showing what has been stated, that he has overlooked many of the circumstances of the case. Therefore he has applied his mathematics without considering many of the main points of the question. Mathematics are very powerful, something like a dentist's instrument, which if not rightly applied, pulls out the wrong tooth; and then the dentist has to convince the patient that he has not got the tooth-ache. Considering that Mr. Barrass is not a naval man, and has not been to sea professionally, this paper is altogether a very creditable production.

I might make a remark upon the paper from Colonel Parkinson that was first read. He proposes to put wood outside. The main object that he seems to have for this is merely for the purpose of coppering. It is a great desideratum to be able to copper a ship. A plan has been proposed by Mr. Grantham, and I think it is an excellent proposition.

There is another point in the paper which did not seem to be dwelt upon, but which I think is perfectly sound. It is to put the wood on the outside of the iron, rather than the iron outside the wood. A great point to be arrived at is to take up the intense velocity of the shot on first striking. By doing that, the shot will not penetrate the iron; but if you allow the shot to come in contact with the iron when it is at its highest velocity, it will penetrate it, and penetrate it more rapidly in proportion to the greater velocity and the greater weight of the shot. I believe wood acts more truly as a buffer when it is on the outside of the iron than when it is inside. As for the wood being destroyed by shell or by shot, that is quite immaterial, so long as the shot does not touch the real fabric of the ship. It is a complete iron ship, and then the wood is put on outside. Wood is easily repairable, and if it be destroyed it is just what you might expect. You do not expect to go into action and not have your ship knocked about; and not the ship only, but your heads too. As Sir George Sartorius said the other evening, we must be content to take our hats off, and let the shot go through.

A suggestion has been made to me by Sir Frederick Nicolson respecting Mr. Froude's system of raising and lowering weights. I gave Mr. Froude the benefit of the possibility of moving weights; but the fact is you cannot move any large weights in a ship. Take the weight of the "Warrior," a 6,000 ton ship. The weight of the hull must be something enormous. It cannot be less than three or four thousand tons. Just imagine what a large weight would be required, and what a distance you would have to raise it, to make any material difference in that ship! Why, the thing is utterly impracticable. In the remarks I have made I gave him the benefit of the possibility of doing it, but I say it would be impossible to do it from the nature of the problem, from the limitations that you are necessarily involved in in connection with the requisites of a man-of-war.

The CHAIRMAN expressed the thanks of the meeting to Mr. Barrass for the very interesting paper he had read. He had no doubt it would be of great advantage to the public service.

LECTURE.

Friday, April 15th, 1864.

LIEUTENANT-COLONEL T. ST. LEGER ALCOCK, Vice-Chairman of the Council, in the Chair.

MILITARY GYMNASIA.

By ARCHIBALD MACLAREN, Esq., The Gymnasium, Oxford.

WHEN I had the honour, some time ago, of reading a paper on this subject to the members of this Institution, I endeavoured to show the value of a gymnastic training to the soldier.* I desire to-day to do myself the honour of describing the material means which I have found it necessary to employ, and in many instances to devise, for the purpose of carrying out my system of training, which means are now being provided by the military authorities with a completeness which leaves nothing to be desired.

With the first conception of the leading features of the system, I perceived that the construction and fitting up of proper gymnasia would be a *sine quâ non*, indeed must be viewed as an integral part of the system itself; and as in this respect it differs from the military systems of other countries,† which are entirely carried on in the open air, I will, with your permission, mention a few of the advantages arising from the organization of such schools.

The first of these is, the value which regular and consecutive instruction possesses over irregular practice.

In the cultivation of the bodily powers it is quite necessary that the instruction should be progressive—that to-day's lesson should, as it were, be taken up to-morrow and carried a little farther on, and the next day and the next a little farther still, and so on to the end of the course. When thus administered each lesson is in accord with that which preceded it, and with that which is to follow it—each aiding each—

* Journal of the Royal United Service Institution. Vol. vi.
† National Military Systems of Bodily Exercise. By Archibald Maclaren.

each improving that which has gone before—each preparing the way for that which is to come; but this, of course, can only be done where provision is made for regular and consecutive instruction. Now regularity and consecutiveness, it will at once be seen, are quite incompatible with open air practice in any country whatever; and in a climate like ours are simply impossible. There are few days in the year that are really fit or suitable for such practice, or on which men would willingly encounter its discomforts; and a system of bodily training which is dependent upon the favour of the weather is in reality no system at all. My anticipations in this respect have been conclusively proved. In connection with the first gymnasium erected, that at Aldershot, which is comparatively small and inadequate to the requirements of so large a station, it was considered possible to extend the accommodation by the erection of certain machines in the open air, on a convenient spot in front of the building. For this purpose I prepared a plan of a gymnastic ground, embracing some of the most attractive and interesting articles of apparatus, on which exercises of competition and emulation might be performed. This was four years ago; but to this day a learner's hand has not been laid upon them; it is either too hot or too cold—too sunny—too windy—too wet or too something; but the fact stands out that, at a station where the gymnasium could give employment to but a small per centage of the troops, nothing whatever could be done with these open-air erections.

I have alluded to the discomforts of open-air practice; these may seem trifling, but when examined are more serious than appears at first sight.

To execute any gymnastic exercise, or any exercise indeed of any kind in which strength is to be exerted, or is to be derived from its performance, there must be complete freedom of clothing. This simply means that the soldier must be stripped to his shirt and trousers, with his neck open, his head bare, and his sleeves tucked up to his elbows. Now it is of the essence of gymnastic exercises, after the rudimentary lessons, that the efforts will for the most part be brief and energetic, with some necessary standing about,—waiting for and watching the efforts of others. And this with men so employed, and so exposed, and so constituted, is, save on rare occasions, neither sanitary, nor even safe in the open air.

I need scarcely, I am sure, state, that I, of all men, am least disposed to enervate or *coddle;* the whole work of my life has been, and is, and probably will be, to make men not only healthier but hardier; to teach them how to retain the strength they have, as well as how to add to its amount. But if experience has taught me anything, it has taught me this, that more evil may be done by rash and sudden exposure—by what is generally known as the *hardening system*, than by all the coddling in the world. It is not by exposure that men are either strengthened or rendered hardy; they must be strong and hardy, before they are fit to be exposed; they must be seasoned first, and exposed afterwards. If we cannot season a piece of timber by sudden, or extreme, or unregulated exposure, we must not think we

can do so with a living man, or a living anything; and from what I have myself seen, and from what I have learned from those who have had the most ample means of judging, soldiers are as sensible of discomfort, and as liable to injury from undue exposure, as any other class of men.

Another important reason why proper gymnasia are essential is, that they may be fitted up with apparatus of a character and description which could not be attempted out of doors. In elaborating my system of bodily training, I have found it necessary to invent many new machines to yield the special form of exercise which I desired in order to produce certain results in the learner; and almost all those which may be called of an educational character, and have for exclusive object to cultivate the resources of the body, require the roof and walls for support, and the soft floor of the building for safety; and those of an entirely opposite description, which have for special and direct object the teaching of the soldier to surmount obstacles, such as the scaling of walls, traversing beams and platforms, with and without implements and arms, can be erected, and the exercises practised on them, with much greater facility here than in the open air; for every portion of the interior face of the walls, and every part of the internal roof may be utilised for purposes of this kind, turned to immediate account, and made to serve as *bonâ fide* apparatus.

I say nothing of the facilities which a school presents over the open ground for giving and receiving instruction, and of preserving order and propriety among the learners, without having recourse to strict military discipline. For it is quite essential to safety, as well as to advancement, that the strictest order and propriety should be preserved in the gymnasium, at the same time that it is most desirable that formal military discipline should be relaxed during the lesson; and there is no fact more undoubted than this, that amongst gymnastic apparatus, the disposition of the learner to be inattentive and careless, and the difficulty of the instructor in communicating instruction and maintaining order, is uniformly beyond comparison greater in the open air than in the gymnastic school. Neither do I notice the safety arising from the assured condition of the apparatus in the gymnasium, exposed as it is to no atmospheric influence, always dry and always clean. Indeed while the out-of-door apparatus must necessarily be getting worse and worse, the indoor apparatus, if properly constructed, and its materials suitably selected, should be virtually indestructible. Nor do I dwell upon the advantages to the individual soldier, as well as to the service, which the building presents, of utilising bad weather—the very time when the soldier's frame most requires activity to sustain its power—the very time when his professional duties are necessarily suspended: and the equal, if not even greater advantage which it gives of utilising the long winter evenings, thus devoting to a source of health and strength, a leisure which is too liable to be spent in idleness and unworthy indulgence.

I have thus noted a few, and only a few, of the advantages which the gymnasium possesses over the gymnastic ground, but each one of these is most important in itself, and is pregnant with many others.

I would now inquire, are there any advantages on the opposite side, any advantages which the ground has over the building? And, if so, are they of such importance as in any way to counterbalance those which I have just enumerated? These are questions which I have fully considered, and I am prepared to answer, None—not one;—the open-air practice has not one real advantage; it has not even any apparent one which may not be shown to have a reverse influence and bearing.

Its apparent advantages are,—1st, ample space; 2nd, abundance of light; 3rd, pure air.

With the phrase "out of doors" and "open air," we are led to associate ample space, but this signification is often quite illusory when applied to the present subject; for it is found that the very places where gymnastic-exercises are most wanted, where they would prove the greatest boon, are precisely those where ground is scarcely obtainable at any price or for any purpose, namely, in garrison towns and in barracks situated in closely populated districts. In such cases the advantage, of course, is all in favour of the building—in favour of the method which knows how to economise every square foot of ground, and to make it serviceable all day and every day, morning, noon, and night, wet or dry.

A small nook in a barrack yard, 80 feet by 40 feet, will be sufficient for a gymnasium, which will give abundant accommodation throughout the year to a garrison of a thousand men. They require no more ground than the apparatus covers; and they could use no more were it planted in the middle of the widest common in England.

The question of light, when examined, is solved at once; and I have no hesitation in saying that it is in favour of the building; abundant light for any purpose can be admitted into any building; and in the gymnasium it can be so admitted and so distributed, as to meet precisely the special wants of the special exercises.

The question of pure air is less easily disposed of, for there is nothing more essential to health and to health-giving exercise than pure air; while there is, on the other hand, nothing more liable to deterioration, for every breath we breathe acts injuriously upon it,—subtracts from it some portion of the good which it possesses, and imparts to it that which is pernicious; and it must be admitted that this process of deterioration is only sustained where the air is confined around the breather in a building, and is entirely avoided when he stands in the great air ocean out of doors.

Moreover it must never be forgotten that a gymnasium is a veritable temple to health in the highest sense of the word; and pure air, which is desirable everywhere, is imperatively necessary here, absolutely essential during exercise, not only for the perfect aëration of the blood, but as the natural stimulant to physical exertion.

And again, just in the same ratio with the requirement for the purity of the air in a gymnasium, is its liability to deterioration, first by the doubly increased respiration of the inmates—each breath being larger in volume, and each following each, in quicker succession during exercise than when the body is wholly or comparatively at rest; and

secondly, in a great degree also, by the exudations from the skin, which is stimulated to its utmost activity by the powerful and sustained muscular exertion; and it must be remembered also, that while these exudations are increased to their utmost extent by the energy and freedom of the partly denuded body, its escape into the surrounding atmosphere is also by the same means facilitated. Now while these are all incalculable advantages to the individual, and the very source and secret of the health and strength which he derives from exercise, they all tend directly and powerfully to deteriorate the air.

Another point still. Admitting that the gymnasium is occupied to the estimated extent of its working capacity, at the end of an hour (the usual time allotted to an ordinary lesson), the air in the building, were there not an unceasing interchange taking place between it and the external air, would be so deteriorated as to be rendered less suitable to the use, and less pleasant to the sense of the next batch of men, and less and less so with every succeeding one; for it is contemplated that every gymnasium shall be in full operation for many consecutive hours in each day.

Here, then, we encounter these important facts, not only that pure air is essential to health, and to the pleasurable sustentation of active bodily exertion; but that this exertion itself is a powerful agent in its deterioration, and that this deterioration is only felt where the same air has to be inspired and re-inspired, as in a building.

Now as this necessarily applies to all buildings, though not to all in an equal degree, we may be sure there is a way by which this evil can be avoided, for He who planned our existence did so with the full comprehension of our wants,—saw that while we were so constituted as to require the shelter and protection of dwellings, in which to live, and learn, and toil, that these very buildings expose to deterioration the substance on which we depend for momentary existence. The difficulty that seemed insurmountable is at once overcome by the action of the law regulating the constitution of the air itself. On the slightest change in the constituents of the air, such as that caused by respiration, or by the elevation of its temperature, it is impelled to instant motion—forced to shift and change its place, that place being immediately occupied by the surrounding air, so that motion and change of position is induced, proportionate in force and in extent to the primary displacement. This law is in unceasing and unerring operation over the whole surface of the globe, regulating equally the mighty currents caused by the sun's heat on the belt of the tropics, and the slight undulations in an ordinary room, caused by the breath of a solitary inmate. This law is the key to all our rational systems of ventilation. It teaches us to construct our dwellings in such a manner that the air, which is in unceasing motion—a mighty current ever flowing, though changing its direction with proverbial inconstancy—may pass through them in its course, cleansing them of every impurity. It teaches us so to regulate the admission of this current, that at any time, and at any season, it shall be in accordance always with the wants and the wishes of the inmates.

The special mode of ventilation for a gymnasium I conceive to

be—the building must be so constructed that the whole body of air within it may in a few minutes be changed for an equal body of fresh air, for this will be required at frequent intervals. It must be so constructed that the deteriorated air may ascend and pass at once out of the building, and a fresh supply at the same time enter; and these apertures for ingress and egress must be so placed, that the fresh air may be admitted at such distance from the inmates that it shall not strike them in compact cold currents, or draughts, as they are called, but be uniformly diffused; for this must be maintained throughout the working day. It must be so constructed, in fine, that it may be as snug as an ordinary room in winter, and as free and airy as the open heath in summer. And this should be done by what may be called *natural* means; that is to say, by simply bringing the internal and external air face to face, as it were, passing through no intermediate channel, forced together by no artificial means.

Thus much for the purity of the air; but air has other qualities besides purity, for we live in it as well as breathe it—it comes in contact with our skin as well as with our lungs; temperature, therefore, is very important. The air may be quite pure when the thermometer stands at 20 degrees below freezing point, as we have experienced this winter, or rises to 80 in the shade, as we felt last summer; but neither of these conditions are favourable to exercise, and least of all to gymnastic exercise.

Now, in a properly constructed gymnasium, the temperature of the air may be rendered pleasantly cool in summer, and sufficiently warm in winter to let men freely strip for active exercise. We do not want a heated or rarefied air to breathe during active exercise; men have the materials of heat within themselves, and want but exercise to ignite the fuel and sustain the fire; but we *do* want the temperature of the air so raised as to remove actual discomfort in stripping to work, and to dry and keep dry the apparatus, which must come in constant contact with the naked hand, and this can only be done in the properly organised gymnasium.*

Having thus, as I trust, shown the advantages of a properly constructed gymnasium, I will now notice a few of the principles which guided me in preparing a design for a building suitable to the system.

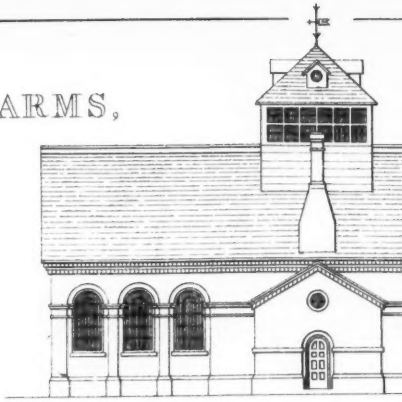
The first of these was, that the gymnasium should be of that form and manner of construction, as to admit of the erection of the desired system of apparatus, and to present the greatest facilities for instruction and supervision. The second, that it should be constructed to meet, in the best manner, the sanitary requirements which I have just noticed.

The third, that in all important respects, the same design should be capable of reduction or extension, so that its working capacity might be in proportion to the garrison where it was erected. In this last respect it was not necessary to compute the absolute working space

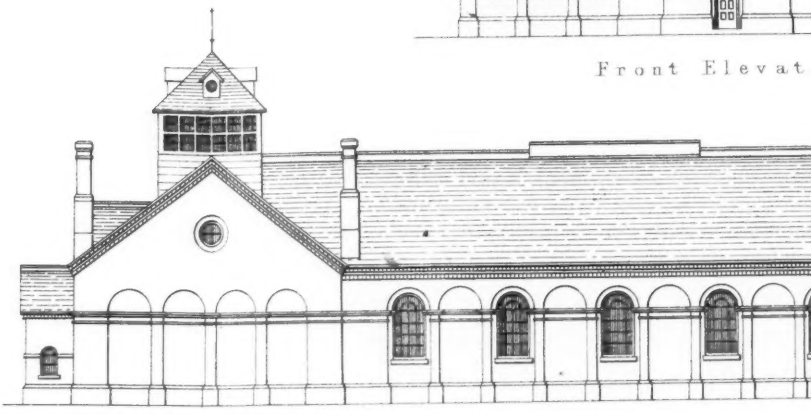
* For this purpose there is nothing so good as the open fire-grate, distributed in suitable places in the different divisions of the building.—A. M.

GYMNASIUM AND SCHOOL OF ARMS,

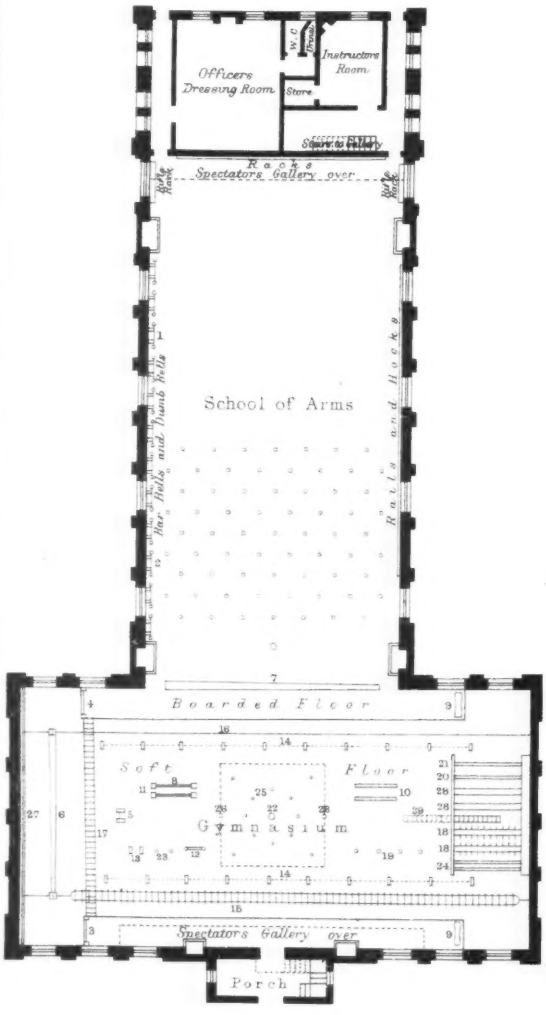
CHATHAM.



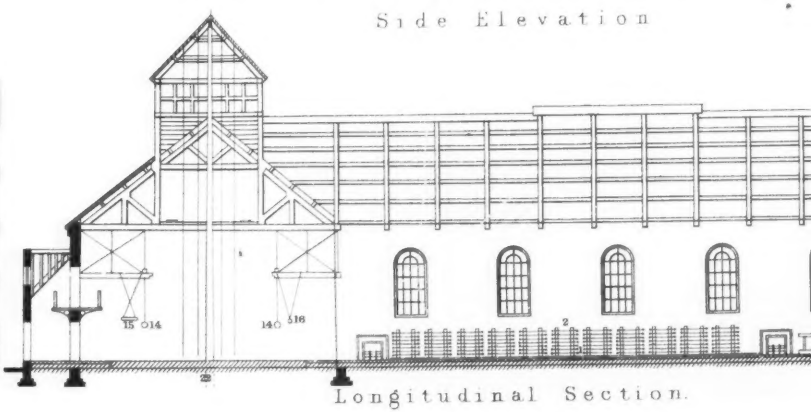
Front Elevat



Side Elevation

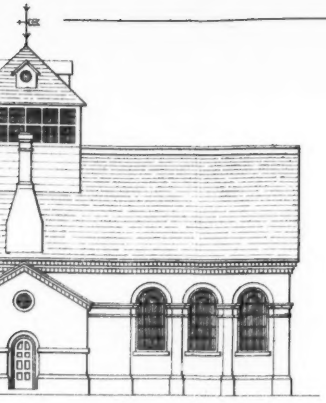


Ground Plan



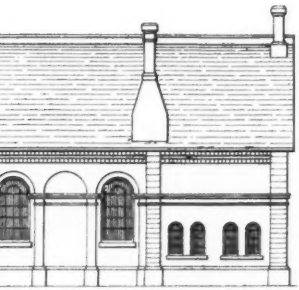
Longitudinal Section.

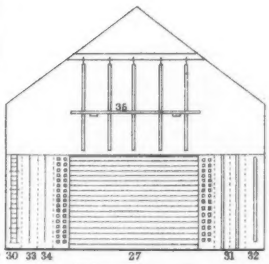
SCALE OF 0 10 20 30 40 50 100



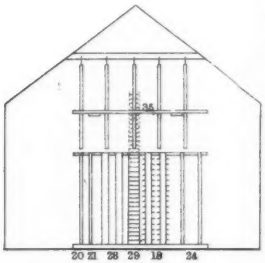
Elevation

Upper Plan over Dressing Room &c.

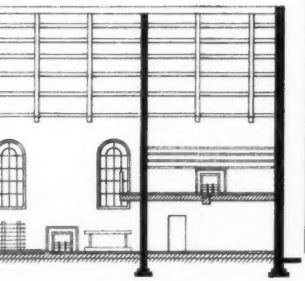


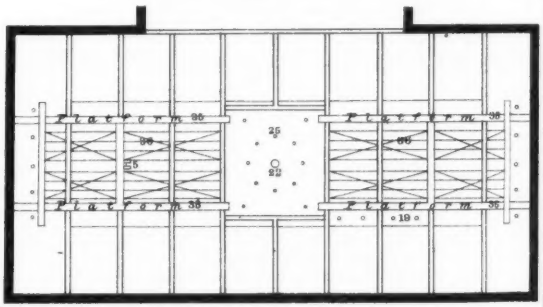


Elevation of
Vertical Escalading Apparatus.



Elevation of
Slanting Escalading Apparatus





Plan of Platforms on Tie-beams.

150 FEET

N° of Section	Title of Section	N° on Plan	APPARATUS.
SECTION 1	Moveable Apparatus	1	*Dumb Bells*
		2	*Bar Bells*
SECTION 2	Exercises of Progression	3	*Leaping Barriers*
		4	*Leaping Rope*
		5	*Vertical Ladder and moveable Platform for Leaping depth*
		6	*Horizontal Moveable Beam*
		7	*Horizontal Fixed Beam*
		8	*Vaulting Bar*
		9	*Vaulting Horses*
SECTION 3	Elementary Exercises.	10	*Fixed Parallel Bars*
		11	*Moveable Parallel Bars*
		12	*Trapezium*
		13	*Pair of Rings*
		14	*Rows of Rings*
		15	*Elastic Ladder*
		16	*Horizontal Bar*
		17	*Bridge Ladder*
		18	*Ladder Planks*
SECTION 4	Free Climbing	19	*Vertical Poles*
		20	*Slanting Pole*
		21	*Turning Pole*
		22	*Mast*
		23	*Pair of Vertical Poles*
		24	*Pair of Slanting Poles*
		25	*Vertical Ropes*
		26	*Rosaries*
SECTION 5	Escalading.	27	*Prepared Wall (Holes, Blocks, Grooves)*
		28	*Planks*
		29	*Inclined Ladder*
		30	*Rope Ladder*
		31	*Vertical Poles, fixed*
		32	*Vertical Pole, suspended*
		33	*Vertical Rope*
		34	*Knotted Rope*
			Against a Wall
		35	*Series of Upper and Lower Platforms with Vertical Poles connecting them.*
		36	*Wire Guard Net under Tie-beams*

required for every squad of learners, but to ascertain the smallest dimensions of a building which would contain with adequate freedom a fair selection of the essential apparatus in the different sections of the system, and from this minimum size to ascend by carefully regulated gradations to a maximum size; the minimum to be adequate to the requirements of a station with half a battalion of men; the maximum to that of our larger stations, such as Chatham. I mention Chatham, because at that station I can perceive, not one only, but all the different classes of men, and each of these in large numbers, to whom the gymnasium must be the greatest possible boon. First, the recruit, in large numbers, this being the depôt of several regiments of different arms of the service; next the trained soldier in considerable numbers, this being a station where several regiments are quartered; and, in consequence, many young officers, for whom it is most desirable to provide suitable and attractive means of healthy and manly exercise.

Indeed, all the features of all other gymnasia should be combined in a gymnasium at a station of this extent and character, and the one recently erected there, and of which a model is before you on the table (see Plate XVIII), in my opinion does so. Nay, all departures from the plan of this gymnasium, should be but modifications of it, to meet some local or exceptional want.

The sanitary requirements of lighting and ventilation have been provided for on the most abundant scale, and as the official regulations on this point have been well considered and clearly defined, there is no room for failure with the most ordinary care on the part of those to whom this special duty is entrusted.

In preparing a system which aimed at providing means for the bodily training of the recruit and for the trained soldier, for the officer of matured frame, and for the yet growing cadet—a system which should yield not only adequate, but suitable and attractive exercise to all of these—it was necessary that it should be very extensive and wide-embracing; that it should be markedly progressive, and above all, that the early courses should be of such a character as to acomplish the setting up, the putting into proper position, and the correction of the evils in gait, action, and attitude of the recruit; that his whole body, and his whole body equally, should receive employment, and that the employment should be of the kind which would at the same time cultivate the contractility of the muscles, and the mobility of the joints; and also promote the expansion of the chest, and give that stimulus to the organs of respiration and circulation which is best calculated to increase their functional vigour.

For these important objects, and for the reasons explained in the book of the system,* I have discarded all exercises of mere movement and position, as affording inadequate action to the muscles, while giving extreme effort to the joints, as being equally severe or inadequate to weak and to strong, as admitting of no progressive advance-

* "A Military System of Gymnastic Exercises, for the use of Instructors." By Archibald Maclaren, Adjutant-General's Office. February, 1862.

ment, and as being inattractive and uninteresting, irksome, indeed, to all; and for my introductory course I have adopted a series of exercises with what I have called *moveable apparatus*, that is, with dumb-bells, single and double-handed. This lesson is so organised, that almost any number of learners may take part in it at a time, all acting by the same word of command.

The whole exercises of the system thus resolve themselves into two distinct kinds: first, those with moveable apparatus, and used for the first or introductory course, in which the learner lifts or wields the article of apparatus, he himself standing firm; and, secondly, those on the fixed apparatus, comprising the bulk of the system, where the learner himself moves or turns, the apparatus or machine being fixed or firm.

This distinction is very important, not only as affecting the character of the exercise to be performed, but the whole material means used in performing it, and actually necessitates a distinct division of the building itself into two parts, each part being in certain respects, in appearance and in fact, the very antithesis of the other. In the first division, that for the moveable apparatus, the floor is retained perfectly free and firm; the apparatus, when not in use, being ranged in racks along the walls. In the second division, the floor is made of soft and elastic material, with every spot of its surface mapped out and studded with apparatus permanently fixed.

For the first division there was needed simply a large room, but as I had long been impressed with the fact that at the depôts, to which our recruits are sent for the exclusive purpose of drill, there was no place where this drill could be carried on in inclement weather, and keeping in view always that the gymnasium should be the place for the instruction and practice of all professional bodily exercises, I so prepared this portion of my design, that at our depôts it might also serve, when desired, for the setting up and position drill of the recruit, and also as a school of arms, where fencing, sword exercise, and bayonet exercise might be taught and practised. One of these exercises which I have just named, fencing, is eminently suitable to officers, and yet it is one in which the officers of our army, generally speaking, are greatly deficient. I am convinced that they require but fair opportunities of instruction and practice to follow it earnestly and successfully, and I have therefore made special provision for the practice of this exercise, by a large fencing school, carefully planned and fitted up for this purpose, with suitable dressing-room accommodation.

I have already stated that in elaborating my system of bodily training, I have found it necessary to invent many new machines to yield the special form of exercise which I desired, in order to produce certain results in the learner; for instance, I have found that few men are equally developed on both sides of the body, as a natural result of the greater employment given to the right side during the period of growth, and this applies not only to the arm, but to the whole side, from shoulder to hip, and not unfrequently including also the lower limb. when the development of the right leg and foot preponderates over the left. Now I consider it of the greatest importance to health, as

it undoubtedly is to serviceability, that this lost balance of power should be restored, this equilibrium of development re-adjusted; and to accomplish this I have found it necessary to invent a number of machines, for the sake of the form of exercise which I desired to be performed on them. Among the first of these I would mention the elastic ladder and row of rings, machines designed expressly to give employment to both sides of the body equally, and especially to the chest and upper limbs, by necessitating that both sides of the body shall perform the same duty, requiring the exertion of the same degree of effort, and that neither side shall be able to aid the other; each side must do its own share of work, and can do its own share only; and therefore if the weaker side be doing as much as the stronger, it will virtually be doing more (being weaker), and the amount of difference in exertion will be of course in relation to the amount of difference in development or power. And therefore, the unerring result of the natural law of development being, *cæteris paribus*, in relation to activity, the weaker side will ultimately recover its lost position and its fitness for fair companionship with its fellow.

I have mentioned the nature and object of these two machines, for the two-fold purpose—1st, of showing that it was what I had discovered to be the actual wants of learners or pupils which guided me in preparing my exercises, and in inventing apparatus which would yield the form of exercise desired; and, 2nd, of showing that it was the form of that apparatus and the nature of the exercises to be performed on them which determined the form and construction of the building itself.

For instance, an important section of apparatus is that which teaches the soldier to clear objects by running, vaulting, and leaping; therefore for these considerable length is required. A second section of an elementary character, as the horizontal bar and the two machines which I have just described,—machines all capable of being worked by large numbers of men at the same time, and by the same word of command, also requires length; therefore the oblong shape, which admits of the apparatus of these important sections being arranged side by side, has been chosen for the gymnasium. A third section, consisting of all climbing apparatus, whether mast, rope, or pole, requires *height;* but as these are all vertically placed, they may be closely grouped, so that a small portion only of the building needs to be very lofty. These three sections of the apparatus in a very clear manner determine the most suitable and serviceable form of building, namely, an oblong, of a breadth about half the required length, and with one portion of it lofty. The position of this lofty portion naturally falls to the centre; for the two end walls are utilised for escalading, the one bearing every form of vertical apparatus; the other every form of slanting apparatus, connected by narrow platforms running along the tiebeams of the roof, in order to accustom men to traverse narrow objects at a considerable distance from the ground. I have utilised the elevated portion farther by making it serve in lighting and ventilating the gymnasium in the place where light is most wanted, and ventilation, of one kind, may be most effectively obtained.

The same form I found also to be the most suitable for the other division of the building, for the distribution of squads in the introductory course of gymnastics, for their arrangement during drill, and for classes of fencing and sword exercise. And as it was desirable for purposes of supervision and instruction that both divisions should form one building, and that every portion of it should be overlooked from every other portion, these two divisions have been placed rectangular to each other.

I have only now to notice the galleries for spectators. It is most desirable to encourage visitors to the gymnasium; it is wonderful, sometimes, how the presence of visitors serves to stimulate the learners to energetic action, and at the same time to assist in preserving the proper decorum of the lesson; but it is equally desirable that they should not mix among or in any way interfere with the learners. The galleries for spectators in both divisions are so arranged that they overlook the whole gymnasium without encroaching upon the working space.

I have already, on several occasions, laid before the public some of the results of this system of bodily training; first, when divested of its military bearing, in connection with the youths of Oxford, with whom the practice is necessarily voluntary, and liable to every form of interruption; and yet such is the want of systematised exercise with growing lads—such are the innate and latent resources of the human body, waiting but the opportunity of development, and such is the power of this system to draw forth these resources, that I have been able to establish beyond controversy the fact, that every youth who comes up to the University, whatever may have been his previous health and habits, has a large arrear of power still undeveloped, and of which a considerable instalment may be almost immediately obtained.

In a paper which I had the honour to read here two years ago, I was able to show that in a detachment of twelve non-commissioned officers, some of them of many years' service, the results of the system were as satisfactory as upon the young Oxford undergraduate. The men composing the detachment had been irregularly selected, the youngest being 19, the eldest 28, the average age 24; and after a period of eight months' training, the increase in the measurements of the men were—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
The smallest gain ..	5	1	$\frac{3}{4}$	1
The largest gain ..	16	5	$1\frac{1}{4}$	$1\frac{3}{4}$
The average gain ..	10	$2\frac{7}{8}$	$\frac{3}{4}$	$1\frac{3}{4}$

With a second detachment, in which the men were of more uniform powers, the youngest being 22, the eldest 26, and the average $24\frac{1}{2}$, the increase in the measurements, after a similar period of instruction, were*—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
The smallest gain ..	$1\frac{1}{4}$	2	$\frac{1}{4}$	$\frac{1}{2}$
The largest gain ..	7	$4\frac{1}{4}$	$1\frac{1}{4}$	2
The average gain ..	$2\frac{1}{3}$	3	$\frac{7}{8}$	$1\frac{1}{4}$

Within the last two years, the system has been so far extended into the army, that seven large gymnasia have been organized at important stations,† and are now in full operation, giving an ample bodily training to several thousand men; and I am enabled to state, that the returns of measurements on this wide scale confirm the results of the experiment made on small detachments.

It was wisely determined from the first adoption of the system by the Authorities, that the cadets at Woolwich and Sandhurst should have an early opportunity of sharing in its advantages, for whatever may be the value of a powerful and active frame to the soldier, it could be no less to the officer; and the advance in bodily power made by the cadets has fully equalled my anticipations.

I am indebted to Major Hammersley, the officer to whom the direction of the gymnastic training in the army has been entrusted, for a tabular statement of the measurements of a class of cadets at the Royal Military Academy at Woolwich, the youngest 16, the eldest 19, the average age being $17\frac{3}{4}$. In this class, in a course extending over four months, the increase was‡—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
The smallest gain ..	1	$\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{4}$
The largest gain ..	8	$5\frac{1}{4}$	$\frac{1}{2}$	$1\frac{1}{8}$
The average gain ..	$1\frac{3}{4}$	$2\frac{1}{2}$	$\frac{1}{16}$	1

* Vide Appendix.

† The stations where gymnasia are already erected are, Aldershot, Woolwich, Warley, Parkhurst, St. John's Wood London, Chatham, Royal Military Academy, Woolwich, and Royal Military College, Sandhurst.—A. M.

‡ Vide Appendix.

Again, in another form still I have tested the results of the system, not by brief courses or periods of voluntary attendance, but by a year's steady practice from birthday to birthday, with two articled pupils, the younger being 16, the elder 20. In the year's work the increase was—

	Weight.	Chest.	Fore arm.	Upper arm.
	Pounds.	Inches.	Inches.	Inches.
With the younger ..	21	5	2	2
With the elder	8½	6	1¼	1½

I need not make any remark upon these figures. I can make none better than every gentleman who hears me now can make for himself. They simply record a complete transformation of the learner's frame; so complete, as to defy all comparison between it and that he possessed previous to the practice. And it must be remembered that this is not an acquisition to be retained only while following some exceptional course of life. It is what he can never wholly lose in this world again, because it is himself that is altered, it is himself that is changed—altered and changed only by being brought so much nearer to the power which he was designed to possess, and to the place which he was designed to occupy from his birth; a place from which he can never wholly fall, a power of which he can never be wholly dispossessed. Not even by illness can it be taken away; for, as his state was his legitimate state, and his power was a natural power, from illness he will rise again towards the height from which he fell.

In conclusion I would desire to draw your attention to this fact —a fact which all the tests of the system, and all the observations of my life go to establish, namely, that the advantages to be derived from physical training are all in favour of the *youth* of the learner. Get the man while he is young, get him, if possible, while he is growing; every year and every month of his growing time is worth double and quadruple the number of months or years after growth is completed; not only for giving shape and carriage, and activity, and muscular strength, but for giving that stamina of endurance to the whole frame, and that healthy and energetic action to the organs which, so to speak, carry on the whole work of life within the frame, which alone will make the man a man indeed, and enable him really to perform the duties of a soldier.

APPENDIX.

Tabular Statement of Measurements of the Second Detachment of Non-commissioned Officers selected to be qualified as Military Gymnastic Instructors,

FROM OCTOBER 27TH, 1862, TO JULY 12TH, 1863.

No.	NAME.	MEASUREMENTS, &c.						INCREASE.			
		Age.	Height.	Weight.	Chest.	Fore arm.	Upper arm.	Weight.	Chest.	Fore arm.	Upper arm.
		Years.	Ft. In.	Stone lbs.	Inches.	Inches.	Inches.	lbs.	Inches.	Inches.	Inches.
1	Corporal Mellor, 22nd Regiment ..	22	5 $10\frac{3}{8}$	9 13	34	10	$10\frac{3}{4}$				
				10 6	$38\frac{1}{4}$	$11\frac{1}{4}$	$12\frac{3}{4}$	7	$4\frac{1}{4}$	$1\frac{1}{4}$	2
2	„ Pike, 22nd Regiment	23	5 $9\frac{3}{8}$	12 0	36	$10\frac{3}{4}$	$12\frac{1}{2}$	Less			
				11 11	$39\frac{1}{2}$	12	14	3	$3\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{2}$
3	Sergeant Wilcox, Coldstream Guards ..	24	5 $10\frac{3}{8}$	11 $2\frac{1}{4}$	$36\frac{3}{8}$	$10\frac{3}{8}$	12				
				11 4	$39\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{1}{2}$	$1\frac{3}{4}$	$3\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{2}$
4	„ Griffiths, Royal Artillery ..	25	5 $9\frac{1}{2}$	10 6	$36\frac{1}{2}$	$11\frac{1}{4}$	$12\frac{1}{4}$	Less			
				10 4	$38\frac{1}{2}$	$11\frac{1}{2}$	$12\frac{3}{4}$	2	2	$\frac{1}{4}$	$\frac{1}{2}$
5	„ Moss, Grenadier Guards ..	25	5 $9\frac{3}{8}$	9 12	$34\frac{1}{4}$	10	$11\frac{3}{8}$				
				10 1	$37\frac{3}{8}$	$10\frac{3}{4}$	$12\frac{3}{8}$	3	$3\frac{1}{8}$	$\frac{3}{4}$	$1\frac{1}{4}$
6	„ Adams, Scots Fusiliers	25	5 $9\frac{1}{4}$	11 $2\frac{3}{4}$	38	$10\frac{3}{4}$	12				
				11 4	$40\frac{1}{2}$	$11\frac{3}{8}$	13	$1\frac{1}{4}$	$2\frac{1}{2}$	$\frac{7}{8}$	1
7	„ Richards, Royal Artillery ..	25	5 $11\frac{3}{8}$	12 4	$36\frac{1}{2}$	$11\frac{1}{4}$	$12\frac{1}{2}$	Less			
				11 9	39	12	$13\frac{1}{2}$	9	$2\frac{1}{2}$	$\frac{3}{4}$	1
8	Corporal Pentecost, Royal Horse Artillery	25	5 $9\frac{1}{2}$	11 13	38	$11\frac{1}{4}$	13				
				12 5	$41\frac{1}{2}$	$11\frac{3}{4}$	14	6	$3\frac{1}{2}$	$\frac{1}{2}$	1
9	„ Pullin, Royal Artillery	25	5 $8\frac{1}{2}$	11 0	35	$10\frac{3}{4}$	$12\frac{3}{4}$	Less			
				10 11	$38\frac{1}{2}$	$11\frac{3}{8}$	$13\frac{1}{2}$	3	$3\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$
10	Sergeant Elliott, Grenadier Guards ..	28	5 $10\frac{1}{4}$	12 3	$38\frac{1}{2}$	$10\frac{7}{8}$	12				
				12 7	$40\frac{1}{2}$	12	14	4	$2\frac{1}{4}$	$1\frac{1}{8}$	2

Return of Course of Gymnastic Training at the Royal Military Academy, Woolwich,

FROM FEBRUARY 10TH, 1863, TO JUNE 22ND, 1863.

No.	MEASUREMENTS, &c.							INCREASE.				
	Age.	Height.	Weight.	Chest.	Fore arm.	Upper arm.		Height	Weight.	Chest.	Fore arm.	Upper arm.
	Yrs.	Ft. In.	St. lbs.	Inches.	Inches.	Inches.		Inches.	lbs.	Inches.	Inches.	Inches.
1	18	5 1	7 8	29	9	8						
		5 2	7 8	30	9	9		1	....		....	
2	19	5 8	9 5½	28	11	10						
		5 8	9 11	31	11	11			5½	3	....	1
3	17	5 5	9 1	26		8						
		5 6	9 1	29	10	10			....	3	....	1
4	18	5 8	10 0	33	10	10						
		5 8	10 3	35	10	11			3	2	....	1
5	18	6 0	10 13	32	10	9						
		6 1	11 2	34	10	10			3	2	....	1
6	17	5 3	8 1	31	10	9						
		5 4	8 7	33	10	11		1	6	2	....	1
7	18	5 5	7 13	26	9	7						
		5 5	8 2	29	9	9			3	3		1
8	16	5 6	8 3	28	9	8						
		5 7	8 4	31	9	9			1	2	1	1
9	17	5 8	11 3	31	11	10						
		5 9	11 3	33	11	11			....	2	....	
10	18	5 11	11 8	30	10	10						
		5 11	11 8	33	10	11			....	3		
11	19	5 7	10 2	33	10	10						
		5 8	10 2	34	10	10			....	1	....	
12	18	5 10	10 11	32	10	10						
		5 11	10 11	33	10	11		1	....	1	....	1
13	19	5 7	11 13	33	11	12						
		5 9	11 13	35	11	12		1	....	2	....	
14	17	5 6	9 13	29	10	8						
		5 7	10 3	32	10	9			4	3	....	1
15	19	5 10	10 1	27	10	9						
		5 11	10 9	32	10	10		1	8	5	....	1
16	18	5 3	8 13	29	10	10						
		5 3	8 13	32	10	10			....	3	....	
17	18	5 8	11 8	33	11	12						
		5 9	11 8	34	11	12			....	1	....	....
18	17	5 6	9 8	27		8						
		5 7	9 8	30	10	10		1	....	3	....	1
19	16	5 6	8 10	27	9	7						
		5 6	9 1	30	9	9			5	2		2
20	18	5 7	9 1	28	10	9						
		5 7	9 1	31	10	10			....	2	....	1
21	18	6 1	11 12	34		11						
		6 2	11 12	35	11	12			....	1	....	

APPENDIX.

PROCEEDINGS AT A SPECIAL GENERAL MEETING.

A Special General Meeting of the Members of the Royal United Service Institution, was held in the Theatre of the Institution, on Monday, May 2nd, 1864, at 4 p.m., to consider the propriety of altering the Bye-Laws, section II, par. 1, so as to entitle the Officers of the Royal Naval Reserve to become Members without ballot.

Colonel P. J. YORKE, F.R.S., Vice-President, in the Chair.

The CHAIRMAN: This meeting is called agreeably to a notice which has been given, which the Secretary will read, and which will explain the object of it.

I. The SECRETARY read the notice convening the meeting.

The CHAIRMAN: I may mention that the Royal Naval Reserve is a corps that has been instituted since the printing of our rules. The object of this meeting is a very simple one. It is merely to entitle the officers belonging to that body to become members of this Institution, on the same footing as Officers of the Navy, Army, Militia, and so forth. The Council found, that according to the rules, they could not admit these gentlemen on their own authority, and they have been, therefore, obliged to call a General Meeting; a very simple measure will carry out the object in view; and there is a simple resolution prepared, which I will ask Sir Frederick Nicolson to move.

II. Rear-Admiral Sir FREDERICK NICOLSON, Bart., C.B.: I have much pleasure in moving the resolution which has been put into my hands; and it is hardly necessary for me to detain you above a minute, in stating anything with respect to the Royal Naval Reserve. It has long been known by every person who has taken an interest in the Navy, that the great difficulty we had to contend with was in manning ships after they were ready for sea, and likewise in manning ships when, in the event of a great war, it was absolutely necessary to send them to sea without any delay whatever. In order to meet these difficulties, the Royal Naval Reserve was instituted, as drawing men, I may say, from the great reservoir of the seamen of the country, and likewise as being a means of connecting the two services together—connecting the Royal Navy with the Mercantile Marine. I am sure that I and my brother Officers will be most happy to see the Officers of the Royal Naval Reserve members of this Institution; and I have very little doubt that the other members of the Institution, not be-

longing to the naval service, will be equally ready to see them. Those among us who have seen large ships in distant stations—I speak especially of the China, the India, and the New Zealand trade—must be well aware of the superior men which are employed in those ships; and there is very little doubt that in those large establishments, where they take care to employ men of seamanship and ability, they are as fine seamen as any which this country can produce. The resolution I have to move is—

"That in order to entitle the Officers of the Royal Naval Reserve to become members of the Institution without ballot, after the word 'Yeomanry,' be inserted the words 'Royal Naval Reserve,' in Section II, paragraph 1, of the Bye-Laws."

Rear-Admiral E. GOLDSMITH, C.B.: I have very great pleasure in seconding that motion. I perfectly coincide with the mover of it in all the remarks which he has made respecting the Officers and men of the Naval Reserve.

Colonel Lord WEST, C.B.: Gentlemen, I must apologize for offering a few remarks to this meeting, as I seldom take part in the business of this Institution, though I have been for many years a member of it. I wish only to say that I gladly seize the occasion of our meeting together to express my hearty concurrence with the resolution which has been proposed. What class, I would ask, what profession is there in this country, which, in the exercise of its functions, does more, or contributes more to ennoble this country, and to accumulate wealth and riches, which are the sources of power, of dignity, and of grandeur, than the Officers of our mercantile marine? I rejoice that the basis has been widened on which the Naval Institutions of this country are hereafter to rest. I rejoice that the right arm of the power and the strength of the country, which is the Royal Navy, will receive so important an accession of strength and force from this measure, which, for that reason, commends itself to the approbation of all.

The CHAIRMAN: If you like I will read how the rule will run when the words proposed in the resolution are added:—

"*Composition.* Princes of the Blood Royal, Lords-Lieutenant of counties, Governors of colonies and dependencies; Officers of the Army, Navy, Marines, Her Majesty's East Indian Military and Naval Forces, Militia, Yeomanry, *Royal Naval Reserve*, and Volunteer Corps, shall be entitled to become members without ballot, on payment of the entrance fee and annual subscription."

The resolution was put to the meeting, and carried unanimously, and the Chairman declared the business of the day concluded.